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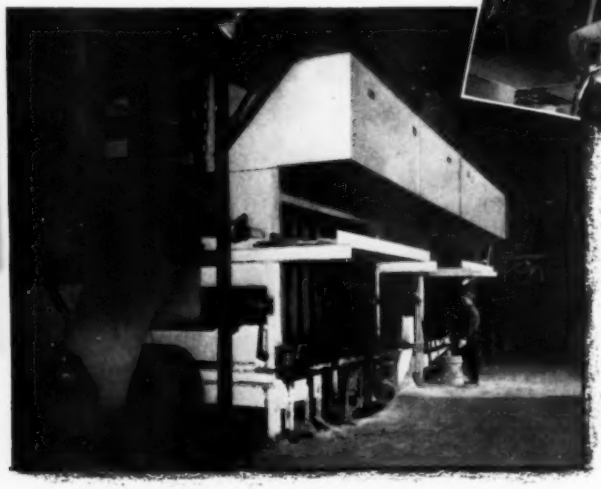
Hartzell can solve your industrial air moving problems just as they did for this Erie, Pa. manufacturer. And do it efficiently and economically with the assurance that the installation specified is *exactly* right for the job expected of it. Perhaps *your* problem is similar to that of this Erie roofing products manufacturer. He was faced with removing noxious fumes from above and around machines used for applying coating to roofing materials (see illustrations). Under certain weather conditions, the plant had to be closed for days. Time and money were lost.

The Hartzell field engineer was called in. He made a careful survey—then specified Hartzell ND36-F-BDS Belt Drive Duct Fans, specially constructed for high temperature service. These fans did the trick. And they are saving this manufacturer money every day of operation.

Hartzell fans and blowers can do the same for you, even in the trickiest of installations. Find out more. Mail the coupon or get in touch with your nearby Hartzell field representative today.



Above and to the Left: Two views of the saturators which apply coating to roofing materials. Two Hartzell belt drive duct fans are in use in each illustration.

The Hartzell field office which handled this job is located at 33 Maple Ave., North Girard, Pa.—Telephone 317.

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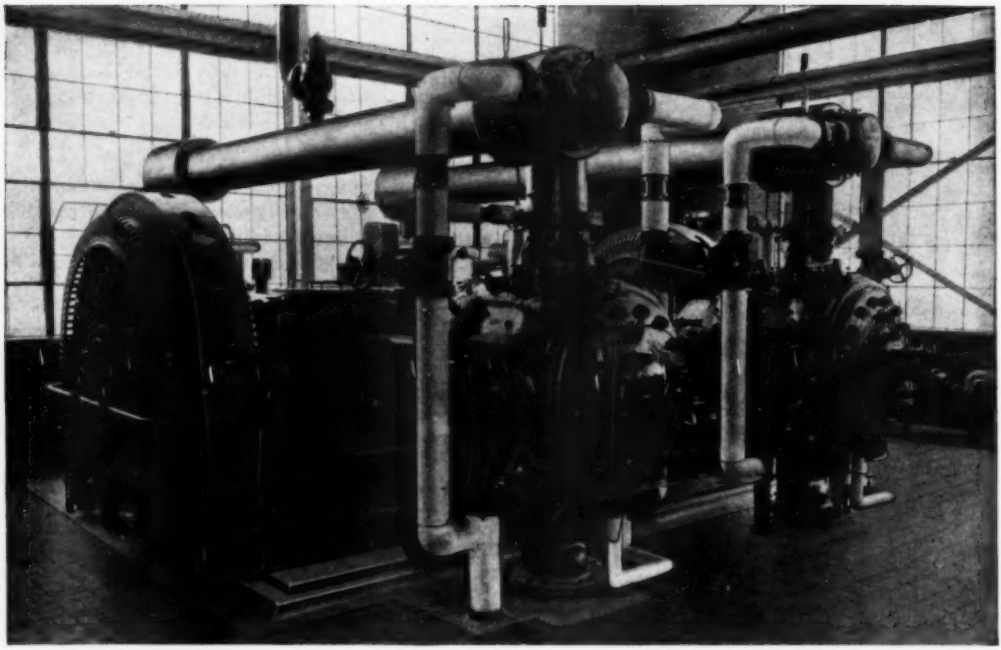

Two 600 bhp Clark CRA-2, Balanced /Opposed, synchronous motor-driven air compressors installed on steel framework on second floor of a Michigan auto body stamping plant.

vibration free...

these compressors can operate alongside even the most delicate of equipment

Perfect balance permitted a widely known Michigan auto body stamping plant to mount these two Clark Balanced/Opposed, Motor-Driven Air Compressors on the second floor, near production machines. Long pipe runs, with their attendant pressure drops, were thereby eliminated.

The fact that all vibration has been eliminated from the Clark Balanced/Opposed design permits installation anywhere. *There just isn't any vibration to be transmitted to nearby equipment!* This is especially important in plants having delicate machines and precision operations which cannot tolerate vibration.

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For information on the complete Clark Balanced/Opposed Compressor line, covering 150-4500 bhp, request Bulletin 118.

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INDUSTRY AND POWER

The Magazine for Engineered Plant Services

VOLUME 43 **AUGUST, 1952** **NUMBER 2**

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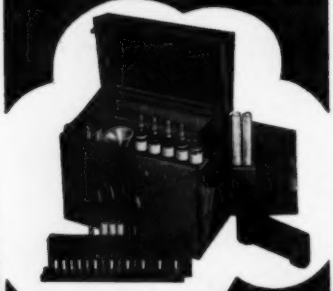

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Acorns of science

Developments not yet available, but of interest to those responsible for Engineered Plant Services

Electrostatic Generator

● Reversing the trend towards new equipment such as cyclotrons to obtain extremely high energy radiation in neuclear investigations, the University of Wisconsin is building a modern, but basically unchanged electrostatic generator of the Van de Graaff type. With it, the University hopes to uncover some of the secrets of the neuclear particle, the meson, and the force which binds the atomic neucleus together. This new force may soon take its place along with the only other two basic forces known, electricity and gravity.

Permanent Magnets

● A new magnetic material developed by the Naval Ordnance Laboratory and composed of bismuth and manganese shows a coercive force of 3000 oersteds, greater than any other known material. Magnets can be made by powder metallurgy, allowing close tolerance in complicated parts without machining. They are produced by heating bismuth and manganese at 700 C and hot processing at 300 C in a strong magnetic field. Evaluation on aging and shock is not yet available.

Use for Pickle Liquor

● In a program under way at Mellon Institute, and partially supported by the American Iron and Steel Institute, coke oven gas is being treated with pickle liquor in a small pilot plant. So far, pure ammonium sulfate has been produced, hydrogen sulfide in the gas reduced 50 per cent, 92 per cent pure sulfur produced, and ferrocyanide compounds recovered. The process may provide a practical method of using spent pickle liquor, and construction of a larger pilot plant has been authorized. One purpose will be removal of at least 90 per cent of the hydrogen sulfide in coke oven gas.

Measuring Displacement

Patent Nos. 2,596,529, -30 and -31 describe a novel vibration system using microwaves so that the only coupling with the observed object is an electromagnetic field. The microwaves are emitted from a wave guide, and partially reflected from the observed surface back into the wave guide where amplitude of the reflected energy is measured as a function of the instantaneous position of the surface. A detector may be supported in the wave guide for creating a varying unidirectional pattern corresponding to the instantaneous standing wave pattern, which in turn corresponds to the position of the vibrating body.

No Echoes

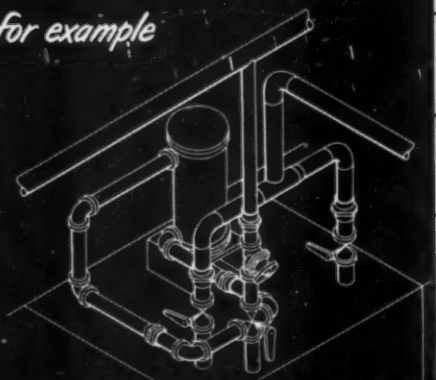
A room without echoes, an anechoic chamber is being built by Westinghouse Electric Corporation to study cause and measurement of noise. There are several similar research rooms in the country today; the interesting angle is that the company estimates that each decibel of sound diminution in its equipment is worth almost one-half million dollars per year. Most other chambers are for the purpose of improving acoustical material or sound producing equipment.

Flowmeter for Gas

Patent No. 2,594,618 discloses a flowmeter for accurately measuring small quantities of gas. The gas is passed through a capillary tube into an electrolyte and the bubbles are counted by suitable electrical circuits.

Are Your Valves Behaving This Well?

...on River Water, for example



THE INSTALLATION

VALVE SERVICE RATINGS

SUITABILITY:	Good design for gritty fluid
FEATURES:	Neoprene disc insert resists cutting
MAINTENANCE COST:	Making big savings here
SERVICE LIFE:	Already 6 to 9 times longer than other valves
CORROSION-RESISTANCE:	O.K. no sign of corrosion
PRICE:	Better than many ordinary valves
AVAILABILITY:	Regular number in Crane line

Crane Iron Body Diaphragm Valves on hydraulic lines to cylinder operators on ash pit gates; Southwark Station; Philadelphia Electric Company.

THE HISTORY

Valves were installed in the hydraulic system when the control cocks failed to shut off tight. But like the cocks, conventional valves put in this service didn't stand up. They couldn't handle the abrasive, sandy river water used for hydraulic operators as well as for ash pit sluicing. They leaked badly in 3 to 5 weeks; had to be replaced.

The problem was solved with Crane Iron Body Diaphragm Valves. Installed more than 7 months, there's been no leakage since; no valve trouble of any kind. The Neoprene disc insert and wide, flat seating surfaces in Crane Valves show no effect of abrasion. Their completely sealed bonnet keeps working parts free of grit.

THE VALVE

In Crane Packless Iron Body Diaphragm Valves, the Neoprene diaphragm acts as bonnet seal only; is not subject to crushing and rapid wear. Separate disc with Neoprene insert shuts off flow even should diaphragm fail. Made unlined or with full Neoprene body lining. Well suited for erosive fluids, sludges, slurries; also for many corrosive services. See your Crane Catalog or call your Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why

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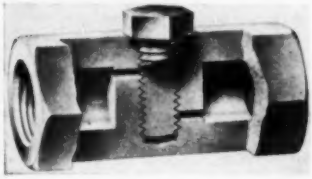
New equipment and developments

Highlights of new products by leading manufacturers

Each new product item has a key number for your convenience in asking for additional, detailed information. Insert key number on return post card on page 115

1—Snubber features simplified design

Controlled rate of flow of compressed air or gas for operation of continuous-reading hydrostatic instruments and for purging pneumatic instrument lines is



provided by a snubber manufactured by King Engineering Co. It also can be used as a pulsation damper. A restricted helical passage provides snubbing action. Ends are tapped for ¼ in. pipe. Flow rate is approximately 0.04 cfm at a 70 psi pressure drop. Maximum pressure is 1000 psi. Complete information is contained in a data sheet.

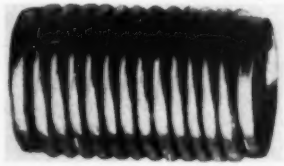
2—Positioning control features accuracy

Extreme accuracy and power at remote distances are design factors of a hydraulic positioning control system, according to The Farris Hydrotorque Corp. Known as Hydrotorque, it is a single tube system independent of

outside energy. Used to hydraulically position valves, throttles, winches and brakes, diesel engines and metering nozzles, it can be located in corrosive atmospheres, high heat or dirty locations. The system will indicate level, flow, static pressure or temperature.

3—Bellows withstand high pressures

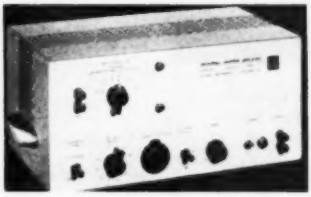
Stainless steel bellows developed by Clifford Manufacturing Co. for higher



pressure applications, have a rating of 3600 psi. Nominal outside diameter of the unit illustrated is ⅞ in.

4—Chopper amplifier has many applications

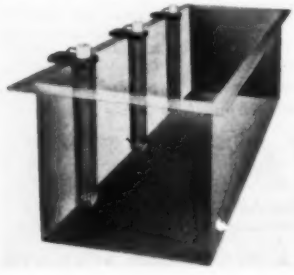
Keithley Instruments has developed a d-c chopper amplifier, model 300, said to have a maximum gain of 800,000, frequency response of 0-500 c, input impedance of 1 megohm, noise and drift within 25 microvolts or 2 per cent of full scale. The instrument will work



with practically all pen recorders, recording galvanometers and cathode ray oscilloscopes. Full particulars are contained in 2-page data sheet.

5—Heater is for corrosive solutions

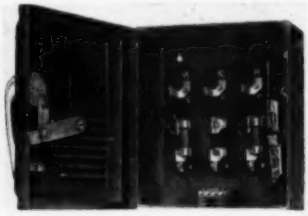
No cleaning or maintenance is required with a fused quartz type electric immersion heater developed by Cleveland Process Co. The Glorod heater is said to overcome many problems inherent to the heating of corrosive solu-



tions. Recommended applications include phosphatizing, electropolishing and electroplating baths. Complete information is presented in a bulletin.

6—Safety switch reduces costs

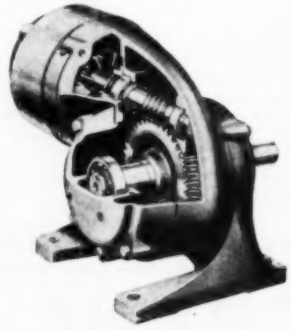
Cost of type A industrial switches has been reduced and the number required for a complete line has been halved by a simplified safety switch. Produced by Federal Electric Products Co., the ACI, with voidable interlock, is said to eliminate need for type



C switches. The addition of a solid neutral block permits the switch to meet requirements which formerly demanded stocking of several types. Ratings are to 200 amp.

7—Worm gear motor has improved design

Low speed right-angle worm gear motors produced by U. S. Electrical Motors, Inc., are said to incorporate



many important design features. Included in the type GW Syncrogear are a cantilever design to protect gear

(Continued on page 10)

TOP HONORS TO THESE R.E.A. PLANTS:

Another Example of Efficient Power at Lower Cost

★ **GRAHAM COUNTY ELECTRIC CO-OP., INC.**
PIMA, ARIZONA

★ **WESTERN MINNESOTA POWER COOPERATIVE**
BENSON, MINNESOTA

★ **CLAY ELECTRIC COOPERATIVE, INC.**
WORTHINGTON SPRINGS, FLORIDA

...and they're all Cooper-Bessemer powered!

THE Diesel Progress 1951 annual award, for the most efficiently operated R.E.A. plant, goes to Graham County Electric Co-op whose plant and engines are shown here. And there's a lot of significance in what Manager Howard Helmers has to say ... "*Our engines and equipment have given remarkable performance and have required a minimum of maintenance.*"

That pretty well sums up the story in Cooper-Bessemer powered plants generally ... and explains why the second and third honors likewise went to plants equipped with Cooper-Bessemers.

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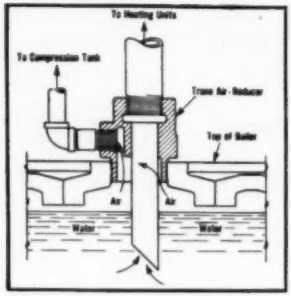
New equipment and developments

(Continued from page 8)

alignment and a single unit pyramidal base said to absorb mounting stresses. Speed ranges are 20 to 155 rpm with gear ratios of 58:1. Made for both single and three phase power supplies, units are available from ¼ to 3 hp. Construction details are dealt with in available bulletin.

8—Air reducer is easily installed

Elimination of two adaptor connections in the design of an air reducer permits easier, faster and more economical boiler installation, according



to the manufacturer, The Trane Co. For removal of air at the boiler, the unit is available for boiler and main sizes ranging from 1 x 1½ in. to 3 x 4 in. in standard increments. Description of the unit is included in 8-page catalog of hot water heating specialties.

9—Water conditioner is for heat exchangers

The Pur-O-San Co., a division of Bradford Chemical Co., has developed a conditioner for water used in heat exchangers and condensers. Known as Pur-O-San Extra, it is said to remove such deposits as scale and sludge, to form a thin impervious film on metal surfaces for corrosion prevention, and to provide full protection against algae and sludge.

11—Reversing switch is for small motors

Reversing drum switches class 2601 type A, manufactured by Square D Co., are said to incorporate many outstand-

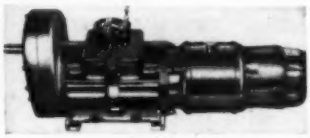
ing features. The units are designed for manual reversing of small motors in such equipment as hoists, conveyers, and machine tools.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

12—Variable speed drive has brake motor

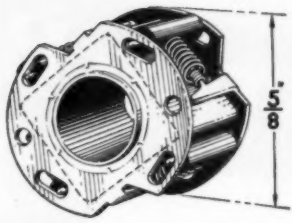
Graham Transmissions Inc. has developed a brake motor for use with Graham transmissions from ¼ to 3 hp. Immediate stops, such as required for indexing and positioning work, are provided. When combined with the drive, which features a wide speed range with



exact speed holding and ability to reset at a given speed, it is said to be well suited for metering and proportioning.

13—Clutch features miniature size

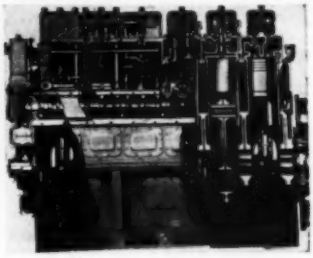
Over-running clutches perfected by High Precision Inc. are claimed to be the smallest commercially available.



Typical applications for the Miniclutch include recording instruments, servo mechanisms and lubricant pumps. The unit, said to stand up under long and continuous use, provides instantaneous, smooth action. Specifications are contained in a folder.

14—Diesel engines are smaller in size

High speed diesel engines, smaller in size and lighter in weight than conventional types, have been developed by Sterling Engine Co., a subsidiary of Graham-Paige Corp. Lower maintenance costs and higher efficiencies are claimed for the units, known as Sterling Viking. Manufactured as either 6 or 8 cylinder units, both have an 8 in. bore and 9 in. stroke. Displacement is 2714 and 3619 cu in. respectively.



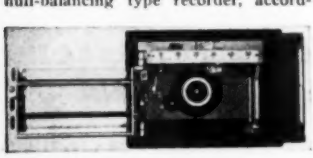
15—Coating fuses with metal

Silicone base aluminum paint developed by Speco, Inc., is said to withstand temperatures to 1700 F. It air dries on cold surfaces in approximately 30 min, and is said to fuse with the metal on which it is applied, thus providing a durable protective coating. Data are given in a 4-page treatise.

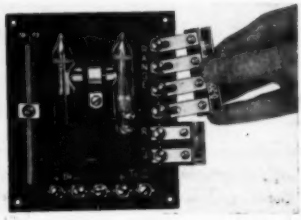
(Continued on page 14)

10—Potentiometer has many operating advantages

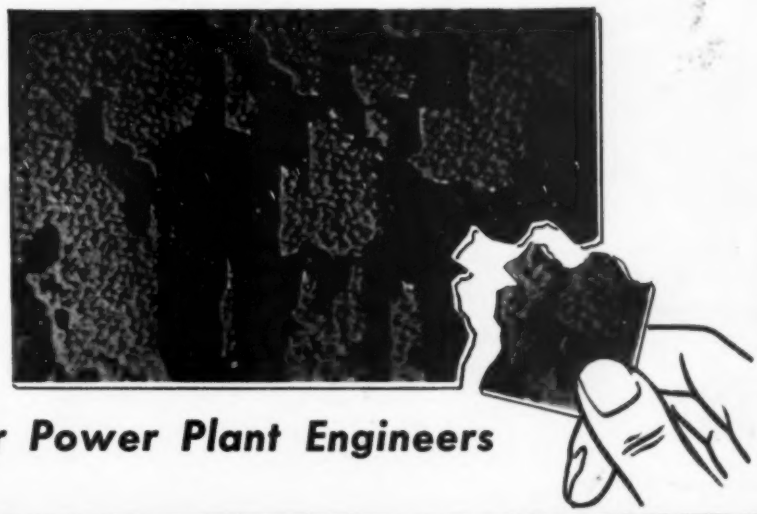
Design simplicity and many operating advantages are incorporated in a null-balancing type recorder, accord-



ing to Weston Electrical Instrument Corp. The chart frame swings out 180 deg with the chart remaining in time sequence. Changing of chart speeds and ranges is simplified. Substituting the desired range standard to change ranges is shown at the right. The unit measures and records any quantity that can be converted into electrical values, such as temperature, speed, power, frequency, and pH. A brochure describes additional features.



JIG-SAW PUZZLE



for Power Plant Engineers

MAGNESIUM scale, magnified fifty times, can look like the jig-saw puzzle it often represents to plant engineers when it begins to affect boiler operation. Quick solution for this and any other scaling or corrosion problem is The Nalco System for your plant. High quality water treating chemicals, plus expert field and laboratory surveillance assure continuously successful results—now, and in the years to come, as long time Nalco customers will affirm. Write for your Nalco Water Treatment Survey today.

NEW DATA ON SCALE IN HIGH PRESSURE BOILERS

Reprints of "Experimental Studies of Boiler Scale at 2,500 p.s.i.," a paper presented at the 1950 Water Conference of the Engineer's Society of Western Pennsylvania, are available free upon request to Nalco. Article includes numerous photos of scale formations on test boiler tubes, and charts showing results of various water treatment methods.

NATIONAL ALUMINATE CORPORATION
6218 W. 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

"WE MODERNIZED OUR PLANT, INSTALLED

This view shows how River Raisin has installed its modern fly-ash re-injection system at the rear of the boilers but outside the plant. The plant also features outdoor coal handling to save additional interior space. Coal is delivered to the stoker hoppers through automatic scales which weigh and record the flow.

If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—*for hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

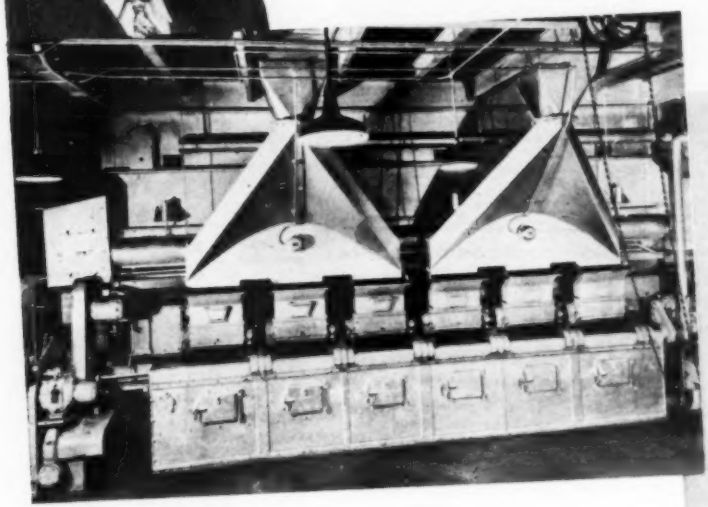
COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

FOR HIGH EFFICIENCY—FOR LOW COST

NEW COAL-BURNING EQUIPMENT, AND CUT OUR FUEL COSTS 45%!"

says Mr. A. J. Goetz, Executive Vice President, River Raisin Paper Co., Monroe, Michigan.

"We recently modernized our entire plant following an extensive engineering survey. New coal-burning equipment was installed...our coal-handling system was redesigned...heat losses were reduced...efficiency raised. As a result, our fuel costs have been cut 45 to 50%—proving to us that for economy and efficiency you just can't beat bituminous coal burned the modern way."



"These modern spreader stokers fully meet the special requirements of our operation. They feature low power requirements, low maintenance, and have the ability to meet fairly rapid load changes. They give us maximum efficiency under all operating conditions."

Modernizing your present plant? Building a new one? In either case it will pay you to get the *modern* facts about coal from a consulting engineer. He'll show you how an up-to-date coal installation can meet your *specific* needs—and at the same time save you more money than you thought possible.

With automatic coal- and ash-handling equipment you can cut labor costs to a minimum . . . and a modern combustion installation will give you more steam for less fuel. Actually, today, you can get from 10 to 40% more power from each ton of coal than was possible a few years ago.

And, if you burn coal, you'll never have to worry about a shortage of fuel. America's coal reserves are virtually inexhaustible, and this coal is mined by one of America's most efficient and productive industries.

This means that coal users—unlike those committed to other fuels—get the advantage of dependable future supply as well as the most stable prices.

BITUMINOUS COAL INSTITUTE
A DEPARTMENT OF NATIONAL COAL ASSOCIATION
WASHINGTON, D. C.

YOU CAN COUNT ON COAL!

New equipment and developments

(Continued from page 10)

16—Industrial light has many uses

Maintenance inspection, as well as other forms of inspection and precision work, is said to be speeded by an industrial light manufactured by Eder Instrument Co. The unit directs a beam

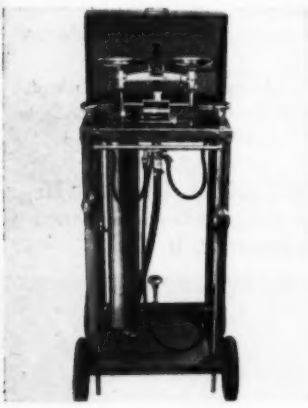
of light into a crevice or cavity to provide better vision. Special attachments are described in available literature.

17—Masonry paint requires one application

One application of Hydrocide Colorcoat, a paint developed by L. Sonneborn Sons, Inc., is said to prime, seal and finish highly porous masonry surfaces. It may be applied by brush or spray, and is said to fill in cracks on old buildings and prevent them in new buildings. Literature is available.

18—Instrument calibrator is portable

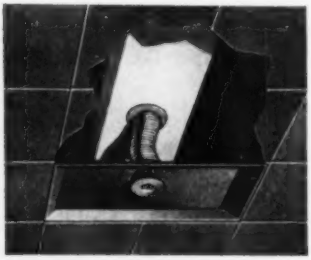
Instruments and controls such as flow meters, draft gages and differential pressure transmitters, with ranges of 0 to 20 in. water, can be calibrated or tested without removing from mountings by use of a portable calibrator developed by Republic Flow Meters Co. Essentially a manually operated force-balance, the unit accurately measures



pressure or vacuum in increments of 0.01 in. Operation of the unit is discussed in 4-page bulletin.

19—Diffusing panel offers low installation cost

Savings in cost of installation are claimed for a ceiling air diffusing panel developed by the Multi-Vent Div. of the



Pyle-National Co. Known as modular Multi-Vent, the unit consists of a 12 x 24 in. panel which fits any standard acoustical metal pan, an adjustable orifice valve and flexible fiberglass tubing for connecting to supply duct. A complete description of the unit, which delivers air at low velocities, is contained in 4-page folder.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

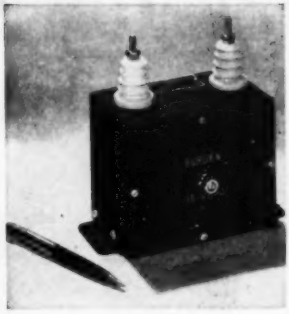
20—Pulleys incorporate split-tapered hubs

For large conveyer installations where horsepower and tonnages run high, The American Pulley Co. has developed a pulley incorporating split-

tapered hubs. Known as Wedg-Tite, the hubs eliminate the use of keys. Pulleys are manufactured in standard sizes to 6 ft diam and 63 in. face width for shafts to 10 in. diam.

21—Reactor provides increased safety

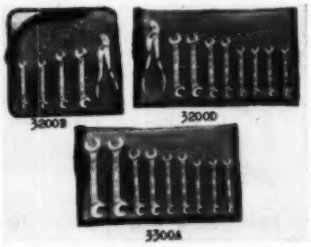
Increased safety in the measurement of d-c voltage is said to be provided by a voltage-measuring reactor developed by the Special Products Sec-



tion of General Electric Co. This is accomplished by insulation of the instrument circuit from the power source. The unit, which provides for remote voltage measurement up to 1200 v, has a plus or minus accuracy of 0.5 per cent of full scale and operates on a power supply of 115 v, 60 ¢.

22—Open end wrenches are midget size

Three midget open end wrench sets have been added to the Proto line manufactured by Plomb Tool Co. These obstruction and electrical type wrenches have many uses, including delicate adjustments of instruments and electrical apparatus. Set No. 3200B contains a 4½ in. plier and four obstruction type wrenches with eight opening sizes from 13/64 to ⅜ in. No. 3200D includes the above plus four additional wrenches to

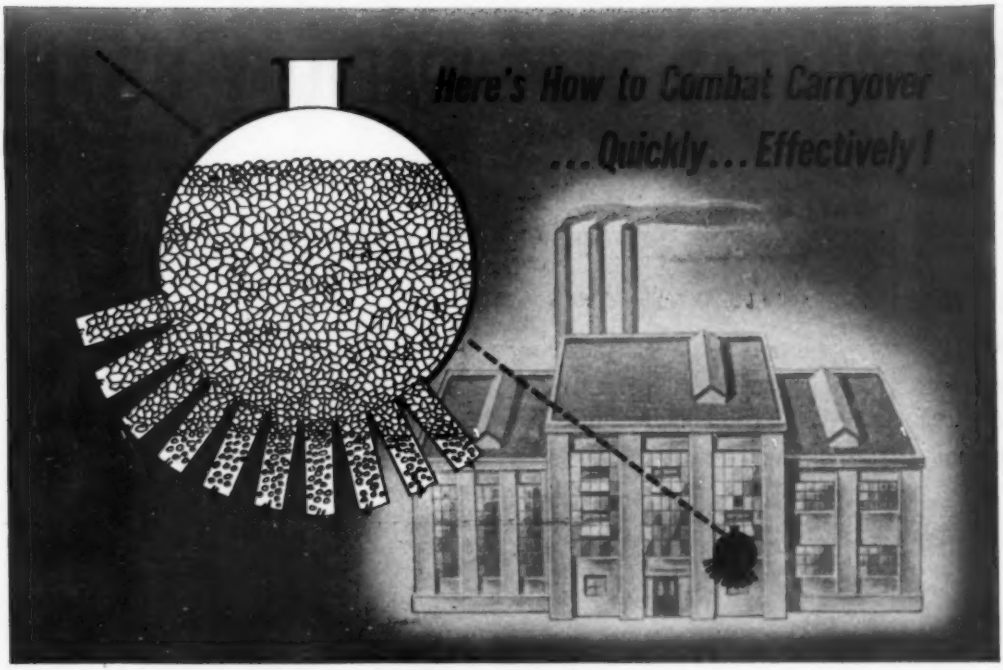


provide eight opening sizes in both 15 and 60 degree angles. Set No. 3300A comprises nine electrical type wrenches, each having the same opening on both ends at angles of 15 and 80 deg. Sizes range from 5/32 to ½ in.

23—Enamel is mildew resisting

Developed for use in areas where mildew control is a problem, as in food processing areas, a mildew resisting enamel formulated by E. I. Du Pont de Nemours & Co. contains a non-toxic fungicide. The manufacturer states tests have shown the formulation to be highly effective. Listed among industries having a need for the product are packing houses, breweries, bakeries, dairies and possibly textile plants.

(Continued on page 18)



One of the most common sources of trouble and expense in steam power systems is carryover and excessive blowdown. But these troublesome conditions, even when extreme, can easily be overcome by the proper application of anti-foam agents.

To illustrate the point, in one plant operating with 100% cold lime soda softened make-up water, boiler water concentrations above 7,500 ppm caused severe carryover with normal boiler water levels. With water level two inches above normal, carryover occurred at 6,500 ppm boiler water solids. It was necessary that boiler water concentrations be restricted by the maintenance of a 16 to 20% rate of blowdown.

Application of anti-foam agents to this problem permitted doubling the boiler water concentrations and reduced blowdown to the range of 8-10%. In addition, heat savings in blowdown totaled more than $30.00 per day!

In this, as in many other cases, the use of anti-foam agents permits efficient plant operation with a minimum blowdown rate.

Why not ask a Betz Engineer to tell you how anti-foam agents can save *you* time, money and effort in *your* plant? Ask him too, about the complete Betz *Specialized* Water Conditioning Service tailor-made to your needs.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

Betz Technical Paper No 115, "Carryover Prevention with Anti Foam Agents" is free for the asking. Write today.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

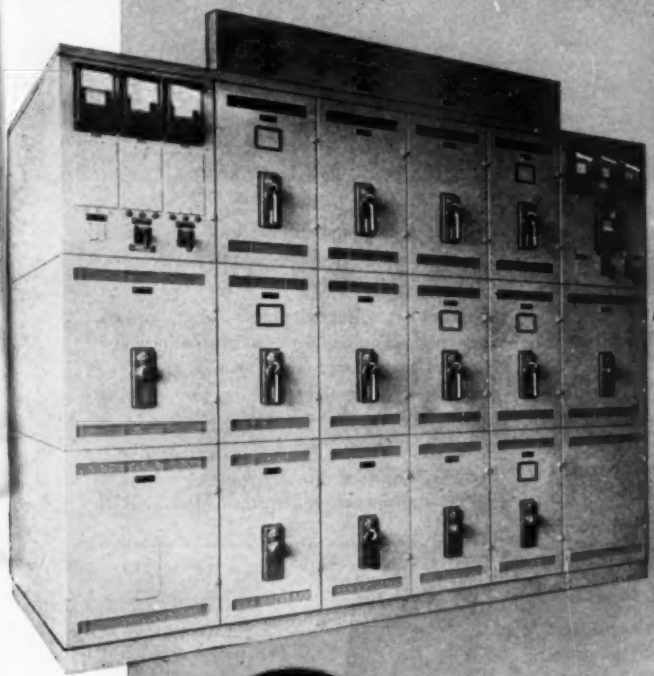
SWITCHGEAR DEPENDABILITY BEGINS

15,000 TO 100,000 AMPERES INTERRUPTING

600 VOLTS A-C, 250 VOLTS D-C

TO 6,000 AMPERES CONTINUOUS A-C OR D-C,
TO 10,000 AMPERES CONTINUOUS D-C ONLY

INDOOR AND OUTDOOR EQUIPMENT



When you buy low-voltage switchgear you buy protection for personnel and equipment. Protection against costly production loss if power should be interrupted by a "nuisance" overload. Protection against the expense of ruined equipment, spoiled processes, and the ravages of fire resulting from a short circuit. Only *circuit breakers* can provide this type of protection!

And to those fully familiar with *difficult* circuit protection problems, *circuit breaker* means *I-T-E*. The history of low-voltage-circuit protection parallels the development of I-T-E circuit breakers.

I-T-E Low-Voltage Switchgear takes advantage of every feature of I-T-E circuit breakers. Thus, it provides users with required protection and safety—along with bonuses of convenience and neat appearance. By specifying I-T-E Low-Voltage Switchgear, you know you have specified the finest circuit breaker.

You can get the complete story on I-T-E Low-Voltage Switchgear by writing for Catalog Section 6004. The I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pennsylvania.

◆ Multunits "600" Construction for Types KA, KB, KC and LG drawout air circuit breakers—the combination for complete protection of low-voltage lighting, power, and distribution circuits.

I-T-E

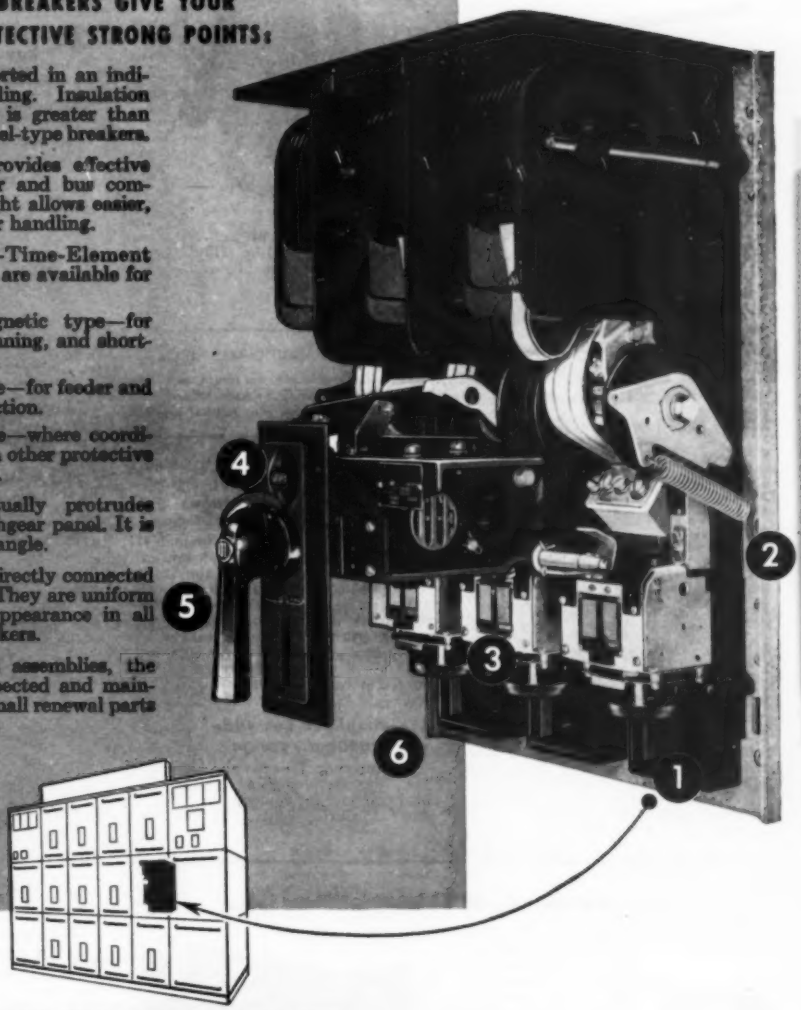
LOW-VOLTAGE

I-T-E CIRCUIT BREAKER COMPANY • 19TH AND HAMILTON STREETS • PHILADELPHIA 30, PA.

WITH CIRCUIT BREAKER PROTECTION!

I-T-E "K" LINE CIRCUIT BREAKERS GIVE YOUR SWITCHGEAR THESE PROTECTIVE STRONG POINTS:

1. Each pole unit is supported in an individual insulating molding. Insulation between adjacent poles is greater than with older, insulated-panel-type breakers.
2. Strong, metal panel provides effective barrier between breaker and bus compartments. Lighter weight allows easier, more convenient breaker handling.
3. Direct acting Inverse-Time-Element overcurrent trip devices are available for every application:
   - Dual thermal-magnetic type—for motor starting, running, and short-circuit protection.
   - Dual magnetic type—for feeder and short-circuit protection.
   - Dual selective type—where coordinated tripping with other protective devices is essential.
4. Position indicator actually protrudes beyond surface of switchgear panel. It is easily visible from any angle.
5. Operating handles are directly connected to breaker mechanism. They are uniform in size, location and appearance in all manually operated breakers.
6. Constructed from unit assemblies, the breakers are easily inspected and maintained. Inventories of small renewal parts are kept to a minimum.



SWITCHGEAR

R&IE Equipment Division: Greensburg, Pa. • Canadian Mfg. & Sales: Eastern Power Devices, Ltd., Toronto • Export Sales: Philips Export Corp., New York 17, N.Y.

New equipment and developments

(Continued from page 14)

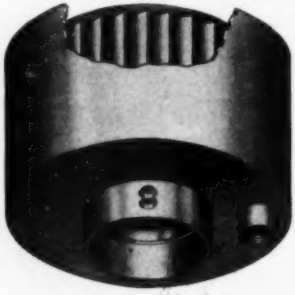
24—Flowmeter operates on magnetic principle

Magnetic flowmeter for remote measurement of molten-metal flow has been announced by the Special Products Section of General Electric Co.

Maximum safety and protection is offered where hazardous metals such as sodium, lead-bismuth and sodium potassium alloys must be metered. It is available for pipe sizes of ½, ¾ or 1 in. Bulletin presents full details.

25—Purifier features high efficiency

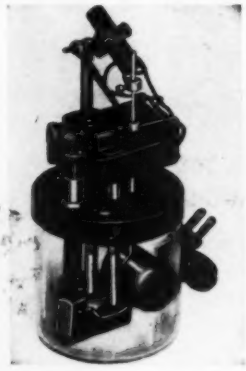
V. D. Anderson Co. has designed the Hi-eF internal downflow purifier for installation in an auxiliary tank immediately above evaporators, packed towers, deodorizers, stills, bubble-cap towers and inside steam drums, flash tanks and receivers. Removal of 99 per



cent of all entrainment is claimed. The unit, which incorporates a multi-stage centrifugal element, is available in outlet sizes of 4 to 24 in. Further information is presented in a bulletin.

27—Miniature pump is for condensate

Developed by Gelber Co., a miniature condensate pump for refrigeration systems operates automatically by means of a float. The unit, which is entirely



rustproof, uses a 1 pt jar. The motor is single phase, 1/90 hp, 110 v. Capacity is 75 gph at zero lift, or 10 gph at 3 ft lift.

TO REQUEST ADDITIONAL FREE DATA

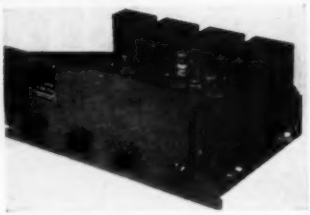
Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

28—Metallic joint seal has many advantages

Easy removal of clean-out plugs is said to be provided by Compound 411, a metallic lead pipe thread lubricant developed by Armite Laboratories. This product, which also serves as an anti-seize coating, is said to be impervious to air, water, steam, oils, ammonia and hydrocarbons, and is satisfactory for temperature ranges from -100 F to 2987 F. Additional advantages are discussed in available literature.

29—Amplifier has wide frequency range

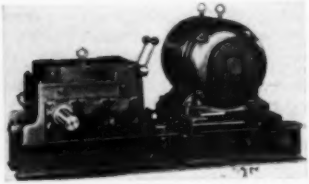
Engineering Research Associates, Inc., has developed a capacitor-coupled amplifier for applications in the industrial control field. The unit, said



to have a high degree of stability, has a frequency response range of 0.1 to 50,000 c. Known as ERA type 2173-2A1, it incorporates four channels.

30—Transmissions are for heavy applications

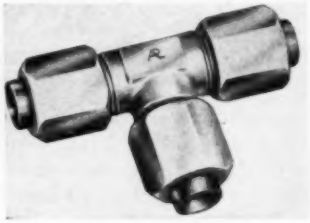
Multi-speed transmissions designed for heavy applications have been developed by Turner Machinery Co. Known as models 2004, 3004 and 5004, they are available in ratings to 60 hp. Models can be supplied with 4, 6 or 9



different speed ratios with, horizontal or vertical mounting. Literature describing the units is available.

31—Fittings are for aluminum tubing

Aluminum tube fittings for industrial use have been announced by Parker Appliance Co. Known as Triple-lok, the line includes male and female con-



nectors, elbows, tees, unions and reducers for ¼, 5/16, ⅜ and ½ in. outside diam tubing.

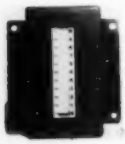
32—Engine pyrometer is portable

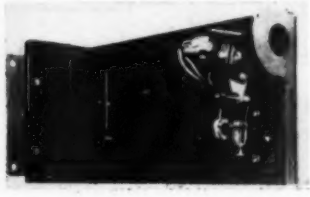
Model 4-321 portable diesel engine pyrometer, developed by The Bristol Co., is designed specifically for test purposes and installations where a permanently mounted type is not available. A bulletin describes how the instrument is used.

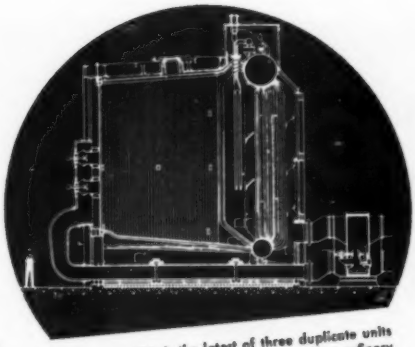
(Continued on page 22)

26—Miniature indicators occupy minimum space

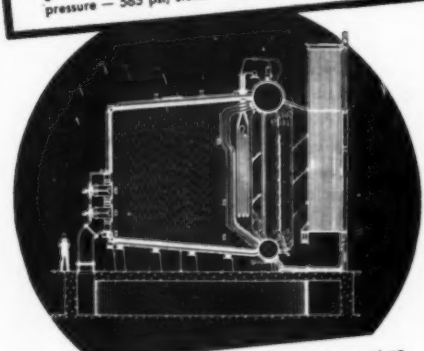
Indicators for liquid level and valve position, developed by the Industrial Div. of Minneapolis-Honeywell Regulator Co., occupy minimum panelboard space. Metal tape, which moves vertically behind an indicating scale, gives the illusion of liquid level sight glasses.



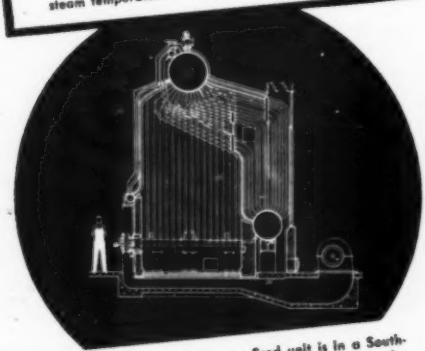




VU-50 Boiler — This is the latest of three duplicate units installed in this Western plant. Fired with oil or refinery gas. Capacity — 250,000 lb of steam per hr; operating pressure — 565 psi; steam temperature — 650 F.



VU-50 Boiler — This unit is one of two duplicates at an Eastern plant. They are fired with oil or gas. Capacity — 100,000 lb of steam per hr; operating pressure—550 psi; steam temperature — 700 F.



VU-10 Boiler — This oil or gas fired unit is in a Southwestern plant. Capacity — 60,000 lb of steam per hr; operating pressure — 150 psi; steam temperature — 465 F. VU-10 capacities range from 10,000 to 60,000 lb of steam per hr.

in Industry after Industry Leaders choose VU

The story's the same, wherever you go . . . in industry after industry . . . wherever steam is used . . . C-E Vertical-Unit Boilers will be found in the plants of many of the leading companies.

The Petroleum Industry, for example . . . one of the largest users of steam for process and power . . . has installed VU Boilers with an aggregate capacity of many millions of pounds of steam per hour. The list below gives evidence of the widespread acceptance of the VU Unit among leaders of the petroleum industry.

Several of these companies have ordered and reordered VU Boilers over a period of years. They know by actual experience what they can expect from a Vertical-Unit Boiler. One company, for instance, ordered its first VU in 1937, its second in 1940, two more in 1942 and another in 1947. A sixth unit was installed in 1950.

So, if you use steam . . . from 10,000 to 350,000 pounds per hour . . . for power or process, take your cue from the petroleum industry — or from any other field where steam is of primary importance. Investigate the lower steam costs you get with the advanced design . . . sound construction . . . consistent reliability of C-E Vertical-Unit Boilers.

Typical Group of Oil Companies that have purchased VU Boilers for one or more plants

Arabian American Oil Company
Cit-Con Oil Corp.
Cities Service Refining Company
Creole Petroleum Corp.
Esso Refinadora do Petroleos
Gulf Oil Company
Humble Oil & Refining Company
Magnolia Petroleum Company
Pan American Refining Company
Petroleos Mexicanos
The Pure Oil Company
Sinclair Refining Company
Socony Vacuum Oil Company
Stanolind Oil & Gas Company

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue, New York 16, N. Y.

C-E

B-571A

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

WITH NEW ILLUMINATOR ON YARWAY FLAT GLASS GAGE...

BOILER WATER LEVEL *Shines*

It's light! It's bright! It's right! You see instantly the accurate boiler water level in your Yarway Flat Glass Gage because *the meniscus at water level stands out like a brilliant star*... thanks to the new Yarway Type "M" Illuminator.

The Type "M" Illuminator is specially-designed to give maximum brilliance to Yarway flat glass inserts, and to spot the water level over its entire traverse. The superior penetration of its blue-white light cuts through extraneous light, dust particles in the air, and deposits on the gage glasses. Effective over longer distances.

New or already-installed Yarway Flat Glass Gages may be equipped with the Illuminator. Yarway Illuminators may be installed in pairs on four-glass gages.

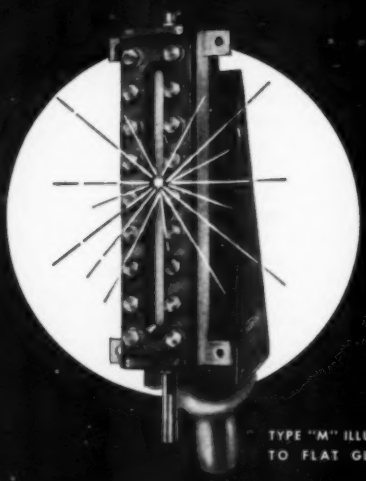
Get in touch with your nearest Yarway office for further details on this latest Flat Glass Gage development, or write direct to...

YARNALL-WARING COMPANY
109 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

A COMPLETE YARWAY WATER LEVEL SYSTEM

YARWAY STEAM

like a Star



TYPE "M" ILLUMINATOR ATTACHED
TO FLAT GLASS GAGE INSERT

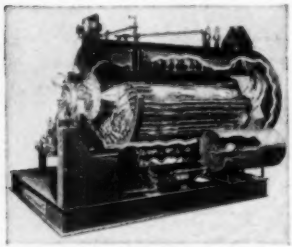
PLANT EQUIPMENT

New equipment and developments

(Continued from page 18)

33—Packaged steam generators feature many sizes

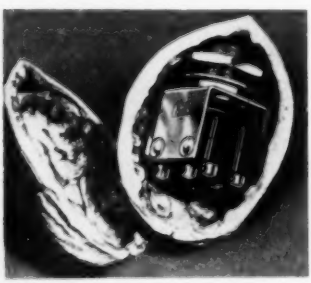
Sixteen sizes of Powermaster packaged steam generators ranging from 15 to 500 hp are now available, accord-



ing to the manufacturer, Orr & Sembower, Inc. The basic component of the three-pass units is said to be the horizontal fire-tube boiler. Burners for light or heavy oil, gas, and combination oil and gas are available. A bulletin contains full details.

34—Electric switch is weather-proof

Development of a weather and oil-proof push button switch has been announced by Micro Switch Div. of Minneapolis-Honeywell Regulator Co. The unit is so compact that the double-pole, double throw assembly will fit in-



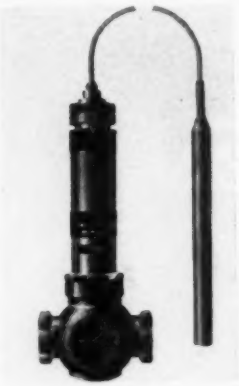
side a walnut shell. Both single and double throw types are listed for 5 amp, 250 v a-c, and either will control 30 v d-c inductive loads of 2 amp at sea level or 1½ amp at 50,000 ft elevation.

35—Fluorescent ballast features compact size

Sola Electric Co. has announced a ballast for lead-lag operation of instant-start hot cathode fluorescent lamps. Design of the unit, called Dyna-tron, is said to result in a smaller and lighter ballast. Advantages are described in a bulletin.

36—Temperature regulators are self-operated

Self-operated temperature regulators, designed in either direct or reverse acting types for heating and cooling ap-



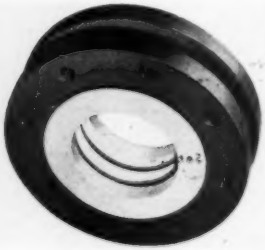
plications, have been announced by Farris Stacon Corp. Known as series V, they are for use with steam, liquids, gases and all fluids not corrosive to brass. Sizes range from ¼ to 4 in. to control temperatures between 25 and 275 F, with a 50 deg range of adjustment. Inlet temperature and pressure are limited to 450 F and 125 psi.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

37—Flexible coupling is for chemical piping

United States Gasket Co., Fluorocarbon Products Div., has developed a flexible coupling incorporating Teflon



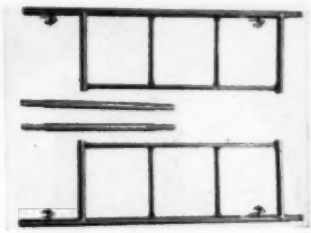
bellows for use in chemical resistant piping. The Chemiseal coupling comprises a bellows of two convolutions assembled with flanges embodying integral gaskets. It is said to eliminate the need for adapters and slip joints. Besides absorbing vibration, slight misalignments and movements of piping are compensated for, and a minimum degree of axial thermal expansion is absorbed.

38—Bridge balance simplifies direct recording

Consolidated Engineering Corp. has developed an 8 channel bridge balance, type 8-108, which may be used for direct recording of the output of strain gages and strain gage pickups without the use of amplifiers. Up to eight 120 to 350 ohm bridges or pickups, comprising four active arms, may be connected to the instrument. Additional details are available in a bulletin.

39—Scaffold end frame is for small openings

Demountable scaffold end frame, Waco type 155-X, which can be passed through small openings in such equip-



ment as tanks, furnaces and boilers has been developed by Wilson-Albrecht Co., Inc. It consists of four sections, the largest being 64½ x 18 in. Assembled, it is 5½ ft high and 5 ft wide.

40—Finish withstands high temperatures

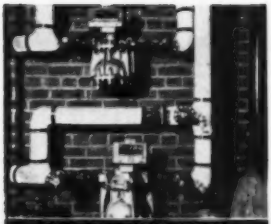
For protection of combustion chambers and outer coverings of heating equipment, Sicon, a silicone-base finish, withstands temperatures to 1000 F according to the manufacturer, Midland Industrial Finishes Co. Available in many colors and aluminum, it may be applied by brush, spray or dip. Details are contained in a 4-page bulletin.

41—Air control valve operates automatically

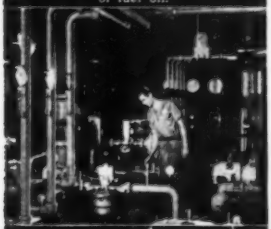
Ventomatic, a control valve for air suction systems and dust collectors, automatically closes when the machine switch is turned off. The manufacturer, Kindt-Collins Co., states this prevents

continual exhausting of warm air when the machine is not operating. Sizes are available to fit ducts from 3 to 8 in.

(Continued on page 26)

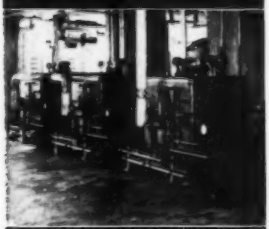


FUEL OIL MEASUREMENT
XACTO METER for accurate control in transfer and storage of fuel oil.

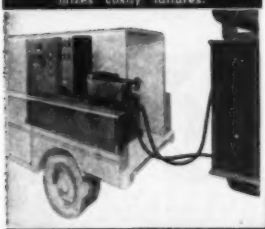


LIQUID BLENDING
BLENDERS for the continuous blending of 2 or MORE liquids.

METALWORKING
FILTERS for continuous coolant filtration systems.



POWER GENERATING
OIL CONDITIONER keeps turbine bearing oil clean — minimizes costly failures.



POWER EQUIPMENT
HYDRO-VOLIFIER portable oil conditioning unit for transformers, circuit breakers and switch gears.

BOWSER ESTABLISHED 1885

Specialists in . . .

LUBRICATION
FILTRATION
OIL STORAGE
METERING

for industry!

Bowser lubrication and liquid control systems are known for dependability in every type of industrial plant. Operating men have learned to rely on Bowser equipment . , . they know it minimizes downtime . . . lowers maintenance costs — stays on the job day-in-and-day-out.

Installations of Bowser equipment range from individual units to complete systems that serve entire plant facilities.

Bowser can furnish complete engineering service and can supply all the necessary equipment for proper installations. You are assured of complete satisfaction, too, because Bowser will assume the entire responsibility of efficient operation.

Bowser men have "know-how" in the handling of liquids. Consult NOW with the BOWSER man in your territory — there's no obligation!

BOWSER, INC. 1368 CREIGHTON AVE., FORT WAYNE 2, INDIANA

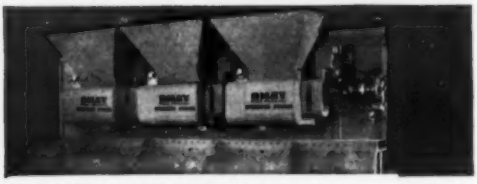
REGIONAL OFFICES • Atlanta • Chicago • Cleveland • Dallas • Kansas City • New York • San Francisco • Washington, D. C. • Hamilton, Ontario

What has caused this tremendous SWING to Riley Traveling Grate Spreader Stokers?

As more and more Riley Traveling Grate Spreader Stokers have been placed in operation Riley Spreader Stokers are being selected by greater and greater numbers of the country's leading public utility and industrial plants—to such an extent that to date in 1952, Riley has sold more traveling grate spreader stokers than all other companies combined.

We believe the fundamental reason for this tremendous swing to Riley is that news of the excellent results and satisfactory performance of Riley Spreader Stokers has traveled rapidly from plant to plant. Such satisfactory performance is largely due to design characteristics and the vast experience of Riley in the stoker field.

THE GRATE SURFACE The grate surface is made up of small clips, two inches wide by six inch pitch, mounted on structural T bars. The use of small grate clips eliminates warping and cracking and assures low maintenance and long life by providing adequate cooling. Clips are of nickel-chrome alloy to minimize growth. A level grate surface and uniform air distribution results.



THE FEEDER-DISTRIBUTOR The feeder is designed to give uniform positive feed regardless of coal characteristics and moisture. Avalanching with fine coal does not occur. The overthrowing distributor gives uniform longitudinal and lateral distribution and prevents damage and outage caused by wedging of foreign materials between distributor and housing.

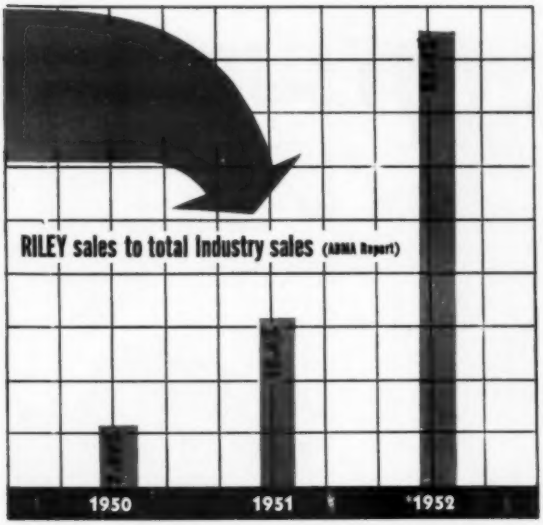
TRADE MARK Rx REGISTERED

RILEY

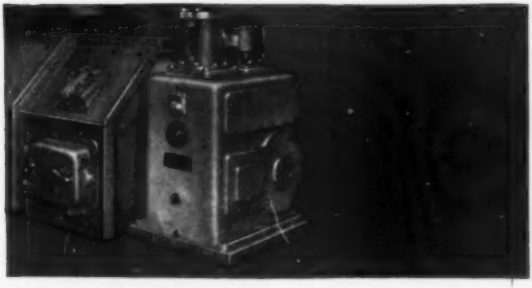
STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Washington Buffalo Pittsburgh Cleveland Detroit Chicago
Cincinnati Charlotte Atlanta New Orleans St. Louis Kansas City St. Paul Tulsa Houston
Denver Salt Lake City Los Angeles Portland Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • ECONOMIZERS



*First three months, latest available figures at time of ad preparation.



THE GRATE DRIVE The Riley grate drive is a hydraulically driven ratchet drive, completely enclosed and automatically lubricated. This simple rugged drive operates with practically no maintenance and is not susceptible to damage in case of grate obstruction. No sprockets, chains or speed reducers are required.

BACKED BY OVER 50 YEARS OF EXPERIENCE There are over 50 years of stoker designing and manufacturing experience back of the Riley Traveling Grate Spreader Stoker, dating back to the two first successful makes of stoker—the Murphy Furnace and the Jones Underfeed Stoker. Riley has been manufacturing traveling grate stokers for over thirty years.

We believe it will pay you to visit some installations before purchasing traveling grate spreader stokers.

All of these Companies have ordered Riley Traveling Grate Spreader Stokers

CARBIDE & CARBON CHEMICAL COMPANY
Whiting, Indiana

OHIO EDISON COMPANY
Springfield, Ohio—two orders

IOWA-ILLINOIS GAS & ELECTRIC COMPANY
Iowa City, Iowa

CELANESE CORP. OF AMERICA
Hopewell, Virginia

CLIFFS POWER & LIGHT COMPANY
Ishpeming, Michigan

IOWA PUBLIC SERVICE COMPANY
Carroll, Iowa

KENNECOTT COPPER COMPANY
McGill, Nevada

GENERAL ELECTRIC COMPANY
Richland, Washington

GARLOCK PACKING COMPANY
Palmyra, New York

SWIFT & COMPANY
Baltimore, Maryland

E. I. DUPONT DE NEMOURS & CO.
Savannah River Project, South Carolina

KAISER-FRAZER COMPANY
Willow Run, Michigan

B. F. GOODRICH COMPANY
Akron, Ohio

UTAH-IDAHO SUGAR COMPANY
Washington

ARMSTRONG CORK COMPANY
Lancaster, Pennsylvania

PENNSYLVANIA ELECTRIC COMPANY
Seward, Pennsylvania—three orders

OHIO EDISON COMPANY
Youngstown, Ohio

OTTERTAIL POWER COMPANY
Crookston, Minnesota

CHAMPION PAPER & FIBRE COMPANY
Canton, North Carolina

CENTRAL ILLINOIS LIGHT COMPANY
Springfield, Illinois

MONSANTO CHEMICAL COMPANY
Springfield, Massachusetts

GENERAL ELECTRIC COMPANY
Louisville, Kentucky

GAYLORD CONTAINER COMPANY
Bogalusa, Louisiana

JOHN DEERE & COMPANY
Alladin, Iowa

SWIFT & COMPANY
Charlotte, North Carolina

BROWN-LIPE-CHAPIN DIV.
GENERAL MOTORS COMPANY
Elyria, Ohio

U. S. GYPSUM COMPANY
Oakfield, New York

STOKELY FOODS
Indianapolis, Indiana

CATALYTIC CONSTRUCTION COMPANY
Fernald Project, Ohio

SANGAMO ELECTRIC COMPANY
Springfield, Ohio

UNIVERSITY OF MINNESOTA
Minneapolis, Minnesota

ROCHESTER MUNICIPAL PLANT
Rochester, Minnesota

CITY OF NAPOLEON
Napoleon, Ohio

CORN BELT POWER CO-OP.
Humboldt, Iowa

U. S. AIR FORCE BASE
Limestone, Maine

CITY OF AMES
Ames, Iowa

ALABAMA ELECTRIC CO-OP.
Andalusia, Alabama

JAMISON COAL & COKE CO.
Farmington, West Virginia

SPOKANE WATER WORKS
Spokane, Washington

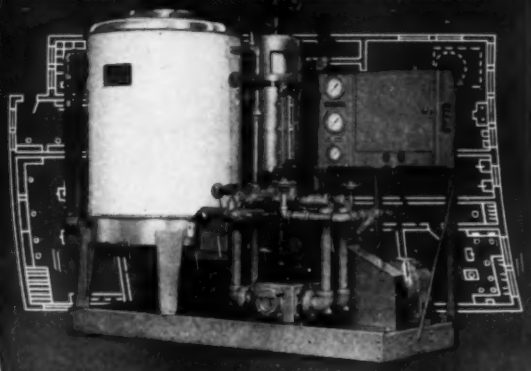
A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

MORE STEAM
Faster and at Less Cost



SPECIFY *Clayton*
FORCED RECIRCULATION
STEAM GENERATORS

Plan your steam plant for long range economy and realize immediate savings on installation and operating costs.

The Clayton *Forced Recirculation* Steam Generator...in sizes from 15 to 100 h.p., and equipped to burn gas or oil, or both...is a compact, self-contained steam plant ready to install and operate as it is delivered. No accessories to buy. No stack, bricking or foundations to install. Move into place; connect fuel and water lines, electricity and vent, and the Clayton generator is ready to operate. Occupies 30% to 70% less space than conventional boilers of same capacity.

Within 5 minutes from a cold start, the Clayton generator attains full operating pressure. Any fluctuating load demand within its rated capacity is instantly and automatically met. No standby losses. High thermal efficiency cuts fuel costs in half, or better. On gas fired units, new electronic safety control proves the flame pilot; automatically shuts down plant on ignition failure or loss of fire. Clayton generators are built to conform to the A.S.M.E. Boiler Code, and are Hartford inspected. Send the coupon for complete catalog.

The coupon below brings a convincing demonstration to your desk.

STEAM PLANT OPERATORS *Mail this coupon*

CLAYTON MANUFACTURING COMPANY IP-8
Box 550, EL MONTE, CALIFORNIA

Send name of nearest distributor and arrange desk demonstration of Clayton *Forced Recirculation* principle. Send catalog.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

Animated flow chart shows how *Forced Recirculation* principle cuts steam costs.

New equipment and developments

(Continued from page 22)

42—Magnetic trap is non-agitating

Increased trapping action and minimum agitation in the process line are advantages claimed for a magnetic trap developed by Tri-Clover Machine Co.

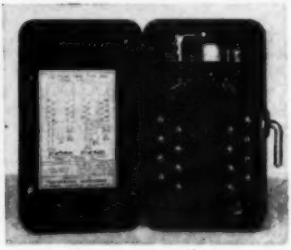
For application in the processing of chemicals and food products, this full flow sanitary trap is fabricated of type 316 stainless steel. Sizes of 2, 3 and 4 in. OD are available with a choice of threads. A complete description of design and operation is presented in a bulletin.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

43—Timer features versatility and accuracy

Electronic timer type 3011L1 has been developed by Photoswitch Inc. for applications requiring long life repeat-cycle operation or precise accuracy. The unit, for intervals from 1/20

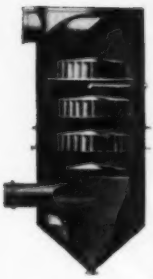


sec to 4 min, provides four basic types of timing: interval; delayed action; automatic repeat; and programming. Many variations are also possible. Power consumption is 25 w for 115/230 v, 50-60 c operation. Available literature contains complete descriptions.

(Continued on page 29)

MULTI-WASH *Systems*

FOR SAFE, EFFICIENT, ECONOMICAL CONTROL OF HAZARDOUS DUST AND FUMES CONDENSIBLE VAPORS OR SOLUBLE GASES



This battery of *four* Multi-Wash Collectors are handling vapors from one of the hottest operations in the chemical industry, involving hydrochloric and hydrofloric acids.

An alkaline solution is used to wash the acid vapors, thus rendering them harmless. This solution also eliminates the necessity for special, expensive materials in the construction of the towers. An inlet sleeve, lined with corrosion resistant material for acid gases is used at the point of entrance to the collector.

Where processes require removal of numerous gaseous contaminants, Multi-Wash Collectors are specially designed to handle multiple liquids in several stages of impingement.

Collected material and washing liquid flows continuously from the outlet at the bottom of the tower to a recirculating and settling tank or back to process as required.

For the most efficient system for contamination control consider Multi-Wash in your plans. Further information and applications supplied upon request.

SPECIAL FEATURES

Include Vari-Vanes for additional impingement surface to collect sub-micron range materials —Multiple Inlets to simplify ductwork and prevent flash—back fire into other branches. Bleeder Inlets for variable gas volume and additional cooling in lower chamber of collector. Extra Water Inlet for heavy dust loads or to cool gas by flash evaporation. Materials of Construction, standard Units of heavy plain carbon steel. Special Units Stainless, Monel, Inconel Steels or special coatings to suit requirements.

SCHNEIBLE

PRODUCTS:

Multi-Wash Collectors • Uni-Flo Standard Hoods • Uni-Flo Compensating Hoods • Uni-Flo Fractionating Hoods • Water Curtain Cupola Collectors • Ductwork • Velocitrap • Dust Separators • Entrainment Separators • Settling and Dewatering Tanks • "Wear Proof" Centrifugal Slurry Pumps

CLAUDE B. SCHNEIBLE COMPANY
P. O. BOX 81, NORTH END STATION
DETROIT 2, MICHIGAN

Check First with Dutton

FOR ONLY THE DUTTON ECONOTHERM GIVES YOU OFF-CENTER FIRING

AND ...HERE'S THE EXTRA ADVANTAGE OF OFF-CENTER FIRING

Induces positive, fast water circulation in a rotary motion, resulting in uniform water temperature in shell . . . faster steaming . . . elimination of surging and priming . . . a steady water line at all times . . . higher quality, dry steam . . . and a higher column of water above the furnace. Every point makes sense — makes performance too!

CHECK NOW with DUTTON . . . write for ECONOTHERM Bulletin EC-100B.

COMPACT
•
SELF-CONTAINED
•
FULLY AUTOMATIC
•
ROTARY COMBUSTION
•
UNUSUAL EFFICIENCY, SAFETY
•
GAS, HEAVY OIL, LIGHT OIL FIRING

Other types and sizes — 5 to 250 h.p. See the Yellow Pages in Phone Book for Dutton Representative.

Dutton BOILERS

DIVISION HAPMAN-DUTTON COMPANY

KALAMAZOO, MICHIGAN • BOILER BUILDERS SINCE 1880

New equipment and developments

(Continued from page 28)

44—Line duct booster fan is for heavy duty

Chelsea Fan & Blower Co., Inc. announces a heavy duty belt driven fan, type PLDX, for use in large exhausters

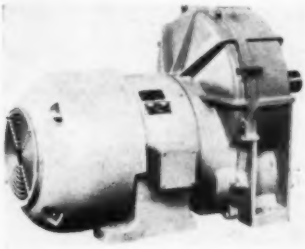
and heating or ventilating systems. Having the motor outside of air stream, it is recommended for air movement to 350 F against static pressure up to 2 in. Units from 16 to 36 in. are available for air movement from 2700 to 23,000 cu ft. Full details are given in bulletin.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

45—Geared drive is for heavy duty applications

Sterling Electric Motors, Inc. announces the addition of larger totally enclosed fan-cooled geared motors to



their line of Slo-Speed electric power drives. The units are double reduction, available with class I, II and III gears.

(Continued on page 30)

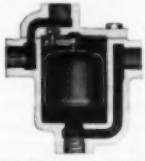
Clark CONTROLS
CAN SAVE YOU MONEY
All Down the Line!

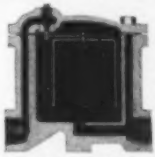
If dollars are running through your steam lines it's time Clark Controls took over. Water in steam lines wastes fuel, cuts efficiency and adds greatly to maintenance costs.

Clark Steam Traps, with Duo-Stop Leverage, drain *twice* the condensate of ordinary traps. Clark Controls on your lines is truly like money in the bank. Write us for full details.

QUICK CLEANING STRAINERS

Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" P.S.I.



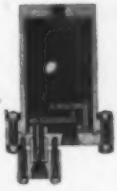


SERIES "70" Inverted Bucket Trap

One of the most popular in the Clark line. Continuous flow capacities up to 2600 lbs. per hour. Sizes ½", ¾" and 1". Pressures up to 200 P.S.I.

SERIES "60" Inverted Bucket Trap

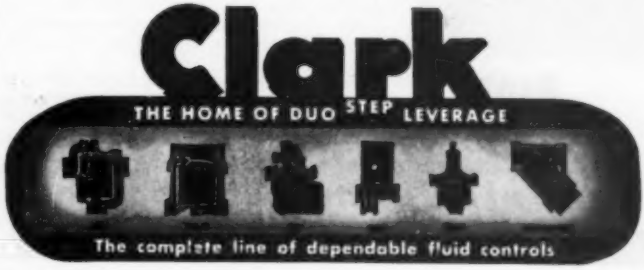
Choice of horizontal or vertical inlet or outlet. For pressures up to 150 P.S.I. "Clark-loy" guided disc and seat.



SERIES "450"

For continuous flow drainage. Pressures up to 600 P.S.I. Sizes ½" to 2". External discharge valve; "Clark-loy" disc and seat.

THE CLARK MANUFACTURING COMPANY
1854 East 38th St. • Cleveland 14, Ohio



"Grates"

For Executives and Engineers Responsible for Engineered Plant Services

KLEMP Metal Gratings

- *Protect against floor wastes*
- *Reinforce all concrete surfaces*
- *Insure fireproof, non-slip footing for men and traffic*
- *Insure efficiency with safety*
- *Insure protection, plus comfort through complete ventilation*

The Klemp Metal Grating Corporation has been serving the needs of those men responsible for the safety of plant employees and the maintenance of all types of flooring for almost half a century. This includes stairways, stair treads, runways, catwalks and tower stairs in industries where there are flooring problems, such as chemical and gas plants, power stations, oil refineries, or where there are turbine rooms and pump rooms. During this time, Klemp has produced and patented several specialized gratings including Hexteel and Floorsteel.

Klemp's engineers have exclusively specialized in the fabrication of gratings such as Hexteel Surface Armor and Floorsteel Flexible Floor Armor for reinforcement of all surfaces where concrete or mastic are applied.

Klemp's diamond riveted and welded gratings are ideal for foot and plant material traffic wherever rugged strength is needed in structural footwalks, stair treads and open steel flooring.

We solicit the opportunity to let Klemp's engineers help solve your most difficult grating problems. Send in your blueprints for quotations today. All types of Klemp Gratings are available for immediate shipment.

KLEMP METAL GRATING CORPORATION

New equipment and developments

(Continued from page 29)

and are AGMA speed 155 rpm and slower, in ratings from 5 to 25 hp. The design is said to permit use of offset shaft and provide for permanent bearing and gear alignment in uniform distribution of load.

46—Paint bonds with any metal

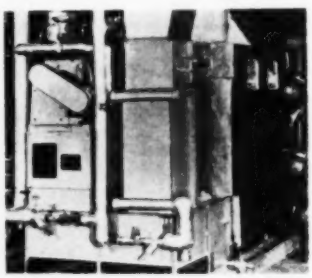
Ready-mixed aluminum paint, known as Super-Hot, becomes bonded to the surface of any metal when subjected to heat from 500 to 1600 F. The manufacturer, Sherwin Bronze Paint Corp., states the coating will not peel, blister or discolor, and that it adds a brilliant, decorative protective coating equal to nickel or chrome electroplating. It is said to be resistant to heat, weather and corrosion, and air dries within 30 min. It can be applied by brush, spray or dipping.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

47—Low temperature units operate continuously

Continuous operation without shutdowns for defrosting is possible with a low temperature package unit for humidity conditioning designed by Kathabar Div. of Surface Combustion



Corp. Continuous delivery of air at temperatures from 32 to -100 F is provided. Capacities of the units, capable of removing 30 to 290 lb of water per hr from the air, are 1350 to 5000 cfm.

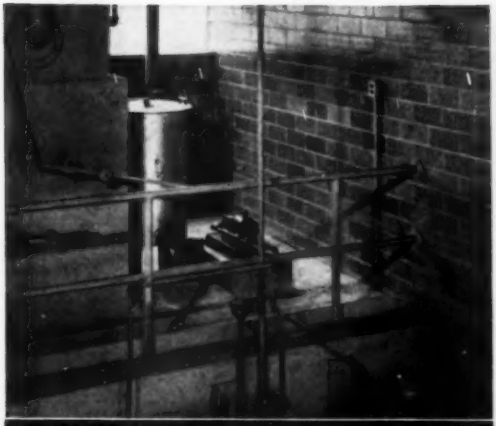
48—Indicator measures differential voltage

General Electric Co. has announced an indicator designed by the Meter and Instrument Dept. to measure differ-

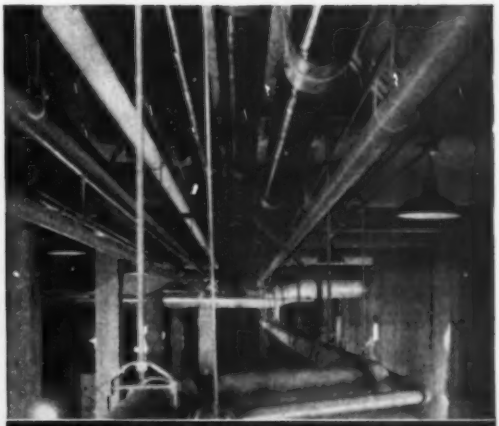
(Continued on page 32)

Dearborn provides water conditioning

for GREATER Pittsburgh airport



BOILER HOUSE—Dearborn 53HA Tank and Type "N" Pump for continuous feeding of Formula 702* to boiler feed lines to eliminate return line corrosion.



HOT AND CHILLED WATER RETURN LINES—Fiberglas covered with NO-OX-IDized Wrapper No. 4 completely insulates piping.

Larger than La Guardia Field and Washington's National Airport combined, the new Greater Pittsburgh Airport is now serving air-minded America. Architectural innovations in the design of the seven story terminal building will serve as an airport model for years to come. Dearborn is proud of its part, the development of a water treatment program and pipeline protection for costly heating and air conditioning equipment installed in this magnificent masterpiece.

Specialists in Industrial Water Treatment and Rust Prevention since 1887, Dearborn gives you a *complete* service (1) analysis of your requirements (2) the correct formulas and equipment to apply them (3) proper test control procedure. Take advantage of Dearborn experience on your next job . . . call in a Dearborn Engineer for consultation. Bulletins sent on request.

DEARBORN CHEMICAL COMPANY

Merchandise Mart Plaza • Chicago 54, Illinois

*U. S. PAT. 2400543

FLUOR COUNTERFLO AIR CONDITIONING TOWER—Water treated with Formula 846 eliminates scale and corrosion. Formula 517 is used in the closed section for the same purpose.

Dearborn Chemical Company, Dept. INP
Merchandise Mart Plaza, Chicago 54, Ill.

- ☐ Send me Bulletin 5000 on Dearborn Industrial Water Treatment.
- ☐ Bulletin on NO-OX-ID Rust Preventives.
- ☐ Please have a Dearborn Sales Engineer call.

Name.....

Company.....

Position.....

Address.....

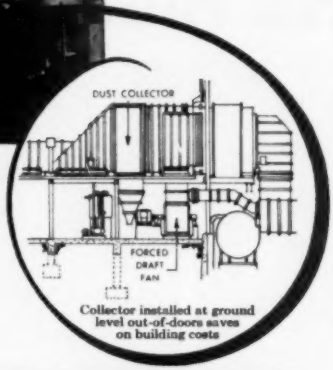
City.....*Zone*.....*State*.....

Dearborn

TRADE MARK REGISTERED

THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

Titus Station
Metropolitan Edison Co.
Reading, Pa.



Collector installed at ground level out-of-doors saves on building costs

Answer *your* specific dust control problems with an

AEROTEC

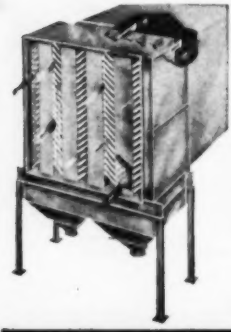
DUST COLLECTOR
exactly tailored to your needs

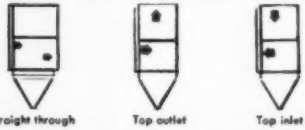
Here is one of the many instances in which the Aerotec Design 3 RAS Dust Collector proved its high efficiency so conclusively that Metropolitan Edison purchased a third unit. Gilbert Associates Inc., of Reading, Pa., were designers and constructors. Three bituminous coal-fired steam generators at this modern power plant, will be equipped with Aerotec Collectors. Layout and breeching are so designed that an Aerotec electrical secondary can be added at a future date without loss of the initial investment.

This mechanical collector, with its multiple, small-diameter tubes, offers you the advantages of high dust recovery in the ultra-fine ranges, even at partial load. The tubes are permanent mold aluminum castings of absolute uniformity. This construction provides the smooth inner wall necessary to ultra-fine dust collection. Tubes are assembled at the factory in lightweight "building block" sections. These assemblies permit flexible arrangement to suit your needs, with the economy of standard construction.

Let our engineers bring to your problems the benefits of their long experience in the field of flyash collection. No obligation.

Typical Inlet and Outlet Variations





Catalog 601 gives you complete details on standard and special Aerotec arrangements, plus other useful data on dust collection. Call or write for your copy today.

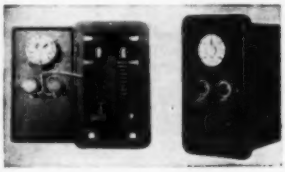
Project Engineers
THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD.
Montreal 25, Quebec — Toronto 5, Ontario

THE AEROTEC CORPORATION
GREENWICH, CONN.

New equipment and developments

(Continued from page 30)

ential voltage and quantities which can be converted to voltage such as amperage, speed and pressure. Basically a high-resistance precision voltmeter containing an electronic amplifier, it is said to possess a high degree of sta-



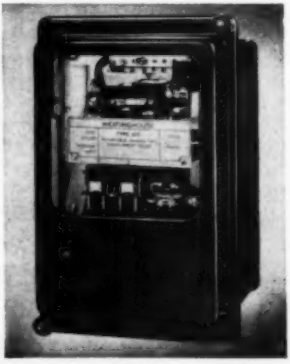
bility and freedom from drift. It can be used with such standard accessories as recorders, indicating instruments and alarm relays. Details of construction and specifications are given in a 4-page folder.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

49—*Relay is slow speed overcurrent type*

Type CO protective relay, a slow speed overcurrent type with inverse or very inverse time characteristics, is available from Westinghouse Electric Corp. Used principally for protection



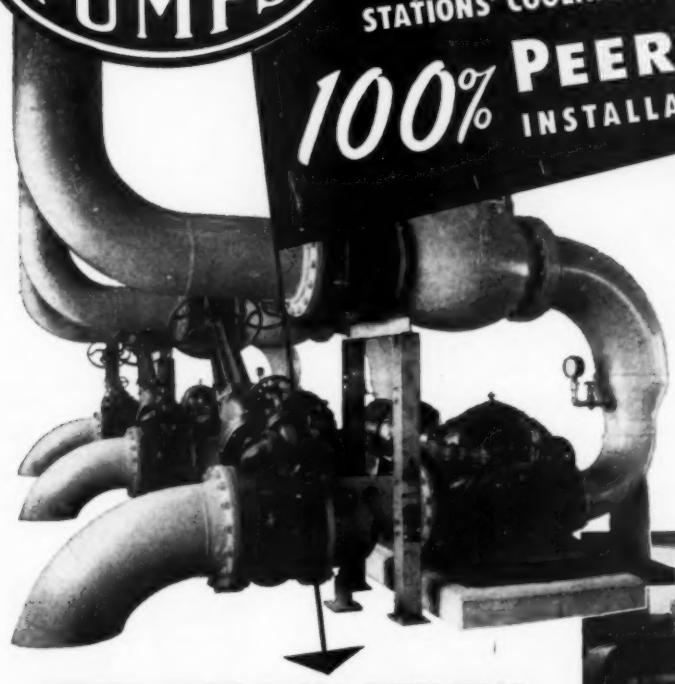
of transmission and distribution lines, the units are available in ranges of 0.5 to 2.5, 2 to 6, or 4 to 12 amp. The three most important features listed are accuracy, flexibility and reliability.

—End

PEERLESS PUMPS

NATURAL GAS PIPE LINE COMPRESSOR STATIONS' COOLING WATER PUMPS ARE

100% PEERLESS INSTALLATIONS



One of the most recently completed natural gas pipe lines runs from Texas to Illinois. Views here show a 100% installation of Peerless pumps in one of the typical 10,000 hp compressor stations now in operation on this line. Pumps are installed in parallel batteries to handle water flow through dual cooling units. One unit cools jacket water, the other unit cools water used in heat exchange units of the lube oil cooling system.

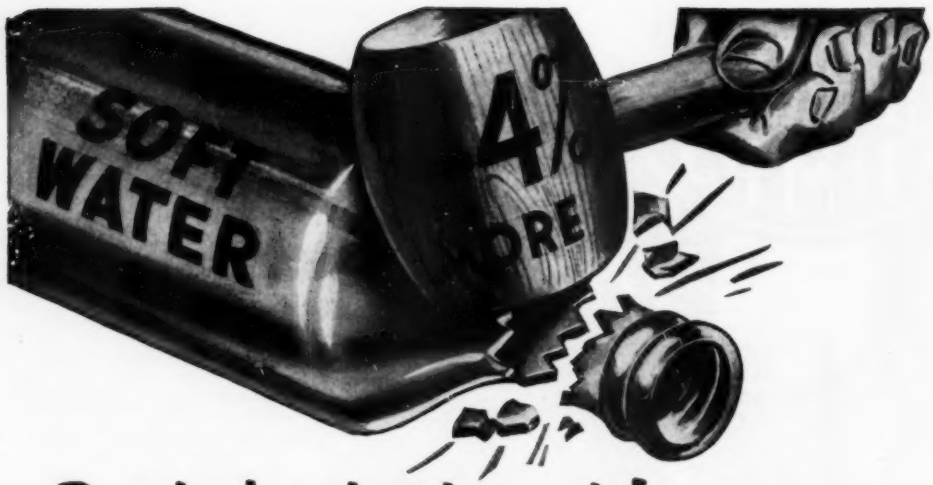
PEERLESS SINGLE STAGE & MULTI-STAGE HORIZONTAL PUMPS HANDLE WATER TO STATIONS' DUAL COOLING UNITS

View above shows typical station arrangement of Peerless pumps installed in one of the compressor stations on the line. Single stage Peerless Type A and multi-stage Peerless Type TU pumps, both of horizontal split case design, are used to handle water to cooling systems.

View at left shows one of the multi-stage Peerless Type TU horizontal split-case pumps installed in these stations. Ample overload capacity is provided so that one or more pumps in each battery can be shut down without impairing cooling water circulation.

Write today for descriptive engineering Bulletins on both Type A and Type TU Peerless pumps.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Address inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Chicago, St. Louis, Atlanta; Dallas, Plainview and Lubbock, Texas; Fresno, Los Angeles; Phoenix, Albuquerque, N. M.; Tulsa



Break that bottle neck!

Get up to 44% more soft water
— from your present water softener
— or with a new Elgin Softener

It's an easy matter to break the bottle neck caused by lack of soft water. You can quickly end those hard water and scale forming troubles which interfere with boiler, process and plant service. Here's how:

If your present water softener is not giving you the soft water you need, you can increase its zeolite softening capacity as much as 44% as diagrammed, by means of the ingenious Elgin manifold arrangement. And by refilling it with new Elgin high capacity Zeolite we can further increase its soft water output *3 to 10 times.*

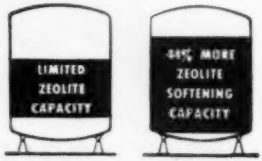
If your present water softener has served its time, or if you are now putting up with hard water, get an Elgin Water Softener of "Double-Check" design. It will deliver up to 44% more soft water than conventional water softeners of equal size utilizing the same type zeolite.

Whichever of these steps you take, the cost will be repaid quickly by the benefits and savings of soft water.

Our nearest representative will be glad to give you complete details. Or write for Bulletin 611 which gives all the facts.

Here's how it's done

By preventing zeolite loss, the Elgin "Double-Check" water softener manifold arrangement permits the use of a deeper zeolite bed and utilizes the zeolite more efficiently. Net result is up to 44% more soft water per regeneration.



ORDINARY DESIGN — **ELGIN DESIGN**

Same size units; same type zeolite

ELGIN SOFTENER CORPORATION

136 N. GROVE AVENUE, ELGIN, ILLINOIS

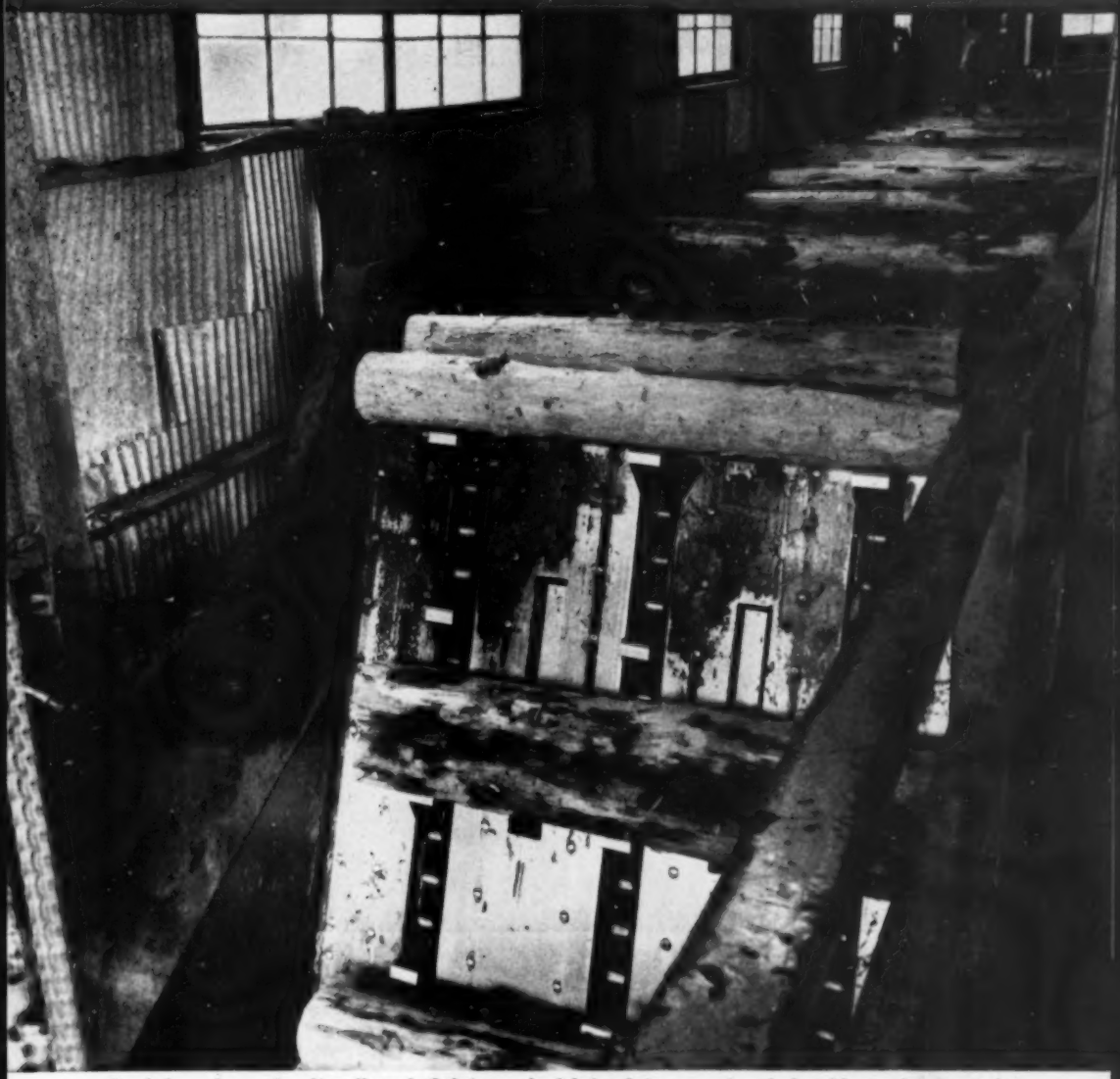
Representatives in Principal Cities

GET THE FACTS
WRITE FOR
BULLETIN 611

The "Double-Check" design of this Elgin softener gives you the basic advantages diagrammed opposite.

ELGIN
SINCE 1908
WATER CONDITIONING
FOR EVERY NEED

B.F.Goodrich GROMMET BELTS AT WORK



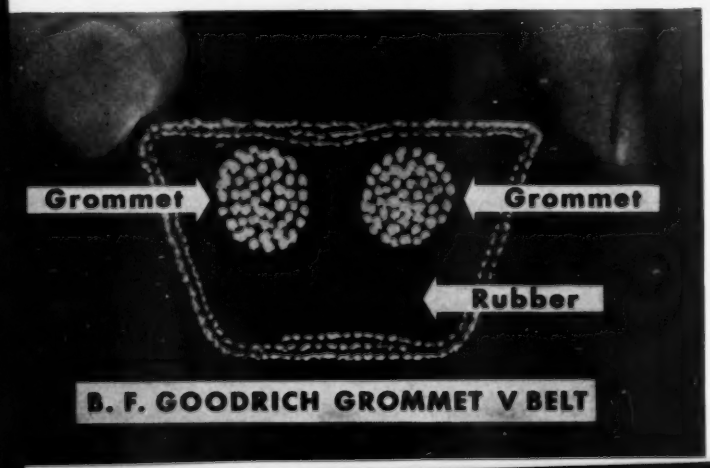
Crash, bang, boom—logs literally peel off their own bark before being ground, cooked and beaten into newsprint.

Strip act — where logs peel

There's more than one way to skin a log. In this plant, instead of shaving off the bark with saws, the logs are dumped into a debarking machine that revolves and rubs them together until they are peeled clean. Fine in theory, but costly when the machine shuts down. And the driving mechanism used to operate this machine was breaking all too often. At every frequent failure, production slowed way down, sometimes came to a standstill before the drive could be repaired or replaced. It took an unusual V belt to solve this problem—as you'll see on the following pages.

Strip act (continued)

Former drives were shocked to death by jolting action of strip act at West Tacoma Newsprint Co., Steilacoom, Wash.



Engineers knew no ordinary belt could handle the job described on the preceding page, so grommet V belts, developed by B. F. Goodrich to give belt users more for their money, were recommended. These belts *look* the same but because of an entirely different construction principle, grommet V belts stand more shocks and heavier loads than any other kind. Installed 2½ years ago, the B. F. Goodrich grommet belts you see in the picture have increased production, reduced costs by giving uninterrupted service with no time off for belt repairs or replacements.

20 to 50% Longer Life

Patented grommet V belts by B. F.

Goodrich represent the only basic improvement since invention of the V belt. Belts last 20 to 50% longer, depending on service. (The more severe the service the greater the increase over ordinary belts.)

What is a grommet?

A grommet is like a giant cable except that it's endless—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

All Cords Put to Work

Each grommet and every part of a grommet carries its share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. Grommet V belts have no center cords, there is no dishing—therefore much more strength in proportion to cord volume.

Better Grip, Less Slip

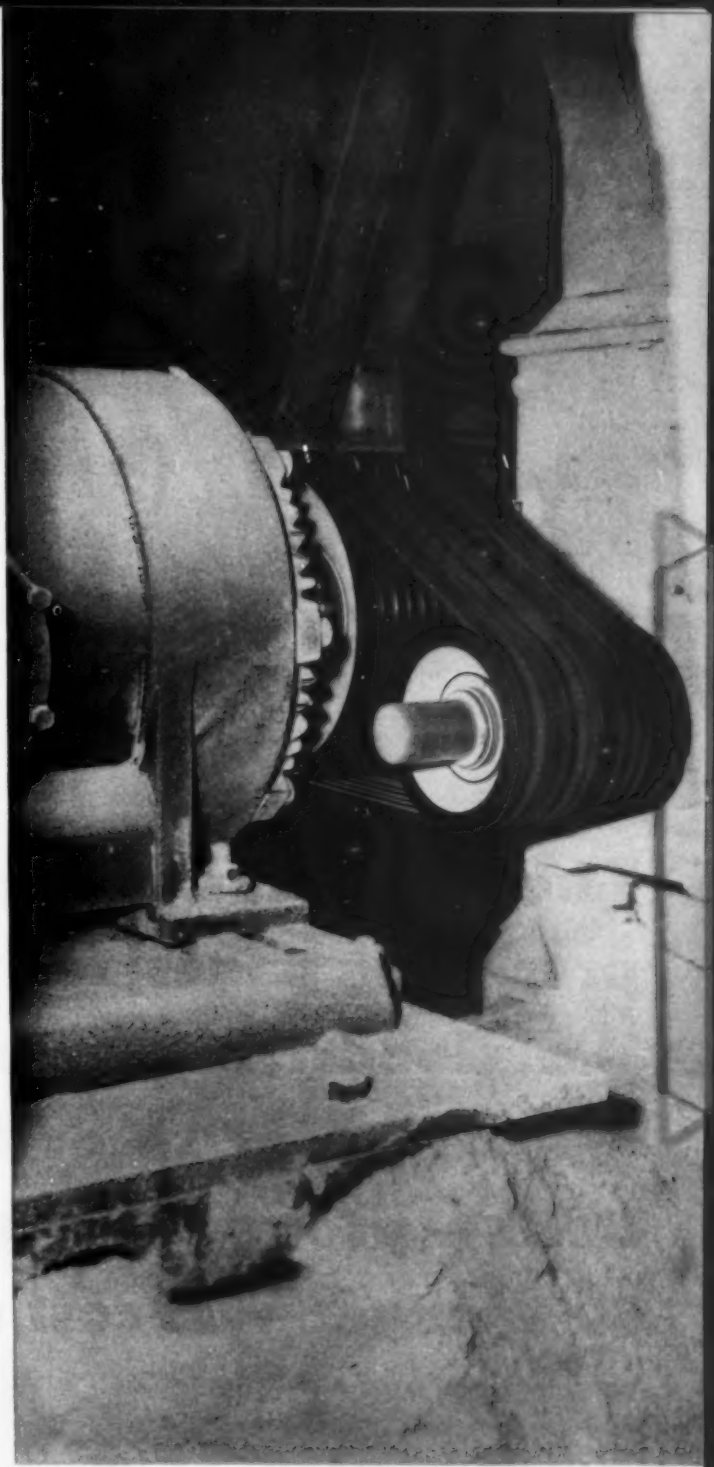
Grommet V belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip there is also less surface wear.

They Cost No More

You save belt costs because belts last longer, save production costs because machines keep running with fewer interruptions, save maintenance costs because they need less attention, yet cost not one cent more than others. Grommet belts are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent No. 2,233,294).

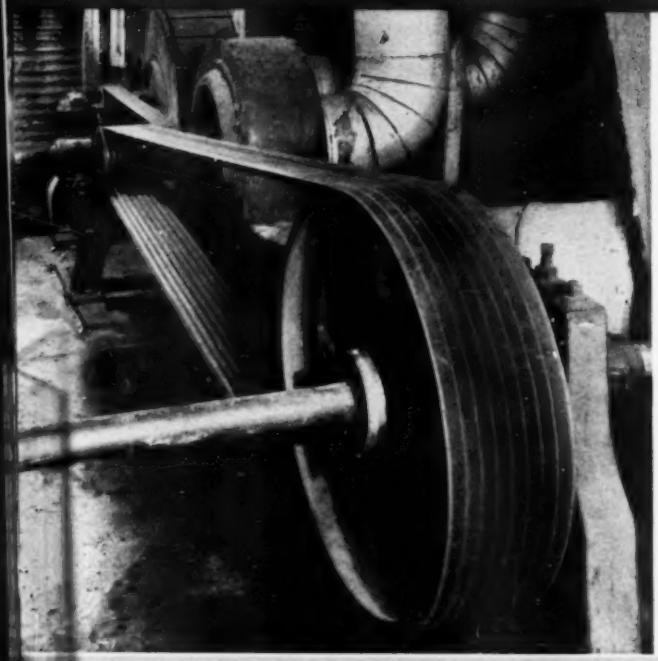
Tough grind

Those belts run a hammermill that grinds grain into feed products. Ordinary belts, previously used, couldn't stand the heavy load, couldn't take the strain of 24-hour-a-day service. There were frequent shutdowns for repairs, and the belts were averaging only 3 months' service. Then a B. F. Goodrich distributor studied the drive, and suggested installing a set of grommet V belts. In spite of running night and day, the B. F. Goodrich grommet belts have already outlasted the ordinary belts 3 to 1, and are still at work.



Belt service was tripled, maintenance costs were cut nearly 100%.

B.F.Goodrich GROMMET BELTS AT WORK



Saved $300 a year

A tandem V belt drive is used in this cotton gin company to run two air blowers. Through a system of pipes, one blower pulls cotton into the plant, the other blows it through various operating stages. With only a four month ginning season each year, uninterrupted operation is vital. Flat belts, previously used, caused constant trouble. They failed frequently during the season, sometimes flying right off the drive. It was costing $300 a year for replacements. A B. F. Goodrich distributor heard of the problem, and told the company about the grommet V belt. The grommet V belt drives you see in the picture were installed, have already given two trouble-free years of service, have done a better job of running the blowers, and made working conditions much safer.

Four months work, eight months vacation.

These typical examples (see preceding pages) tell you why B. F. Goodrich grommet belts are superior to ordinary V belts—prove they last 20 to 50% longer—yet cost no more.

Grommet V Belts BY
B.F.Goodrich
FIRST IN RUBBER

The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio

The Ten Leading Makes Of Vertical Turbine Pumps
√ Indicates Feature Is Standard

Standard Features	Worthington	Pump A	Pump B	Pump C	Pump D	Pump E	Pump F	Pump G	Pump H	Pump I
Seals above and below drain ports (oil-lubricated model)	√				√					
Wearing rings	√				√			√		
Enclosed impellers	√	√	√	√	√	√		√	√	√
Bronze bushings in bowl assembly	√		√	√	√	√		√	√	√
Flanged and bolted bowls on all sizes	√						√		√	√
Sand collars at both ends of bowl assembly (water-lubricated model)	√	√								
Grease-packed bottom bearing	√	√		√						
Choice of oil or water lubrication	√	√	√	√	√	√		√		

CHECK WORTHINGTON AGAINST THE REST

Only Worthington has all 8 vital design features as standard equipment.

Have you ever considered a vertical turbine pump for your industrial applications?

If you haven't, you may be missing a good bet.

For many years the vertical turbine pump was thought of as having only one application—deep well pumping. Recently, however, this efficient liquid handler has been given many other jobs, so that today we're not sticking our necks out when we say: it's an extremely *versatile* pump.

Let's take a look at the four inherent characteristics that make this pump really *versatile:*

1. THE DRIVE UNIT IS REMOTE AND SEPARATE FROM PUMPING ELEMENT. The pump always operates submerged. No priming. No expensive dry pits. No suction or NPSH problems.

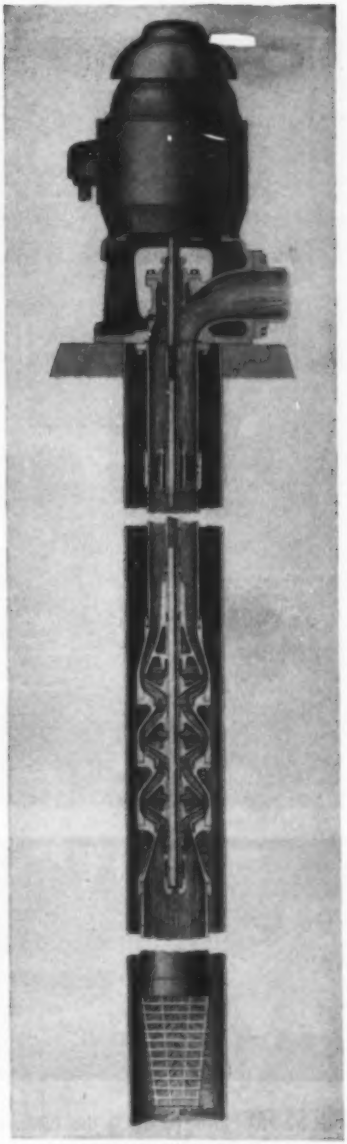
2. SPACE REQUIREMENTS AT A MINIMUM. Because of its vertical design, the vertical turbine pump takes less floor space than other types.

3. MECHANICAL AND HYDRAULIC FLEXIBILITY. Will operate with any type of drive. Discharge can be positioned to user requirements. Can be close coupled or several hundred feet long. Meets head and capacity requirements by varying the number of duplicate stages.

4. IT'S A SIMPLE MACHINE. Unidirectional thrust minimizes alignment problems. Easy maintenance, few moving parts, little friction, long life.

If you think a Worthington vertical turbine might be your answer to a pumping problem, or if you're not quite sure about it—we'd like to hear from you. Remember, Worthington, as the oldest manufacturer of pumping equipment, has the newest and broadest line of vertical turbine pumps.

Send complete data on your application mentioning capacities. Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Vertical Turbine Pump Division, Denver 16, Colorado; Succasunna, N. J.



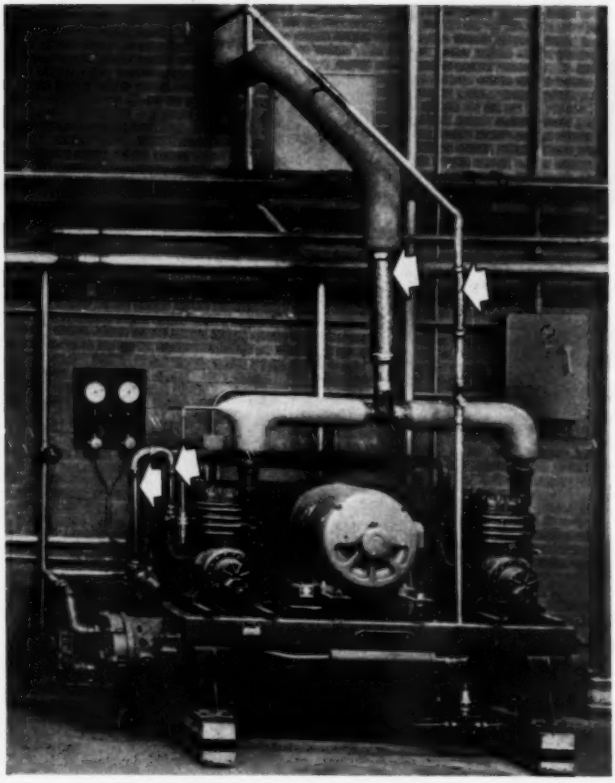
TYPICAL SECTION of the Worthington water-lubricated vertical turbine pump that gives most efficient pumping performance at lowest possible cost.

D.1.11

The World's Broadest Line Assures You The Right Pump For Every Job

WORTHINGTON

Vertical Turbine Pumps



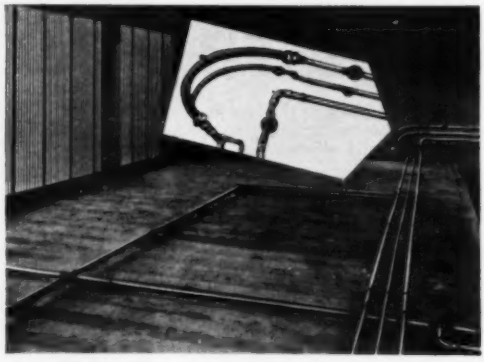
News about flexible metal connectors

Here they absorb VIBRATION, permit EXPANSION, withstand PRESSURE and HEAT

VIBRATION These twin compressors are part of an office air conditioning system. To prevent transmission of noise and vibration to refrigerant lines, American Vibration Eliminators have been used. They have proven their usefulness many times where vibration might crack rigid piping or make maintenance difficult. Leakproof and permanent as piping, they safely convey such liquids and gases as freon, brine, chlorides, etc., under high and low pressure.

PRESSURE and HEAT In this Littleford Pressure Distributor, American Flexible Steel Tar and Asphalt Hose, in constant motion, sprays hot tar under pressure. It handles easily, withstands outdoor exposure. If you want hose that can endure such rugged service, yet installs quickly, is convenient to use, and needs little attention, plan on American Flexible Metal Hose and Tubing.

Write for Booklet SS-50 – gives complete information on American Flexible Metal Connectors and their uses. The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Co., Ltd.

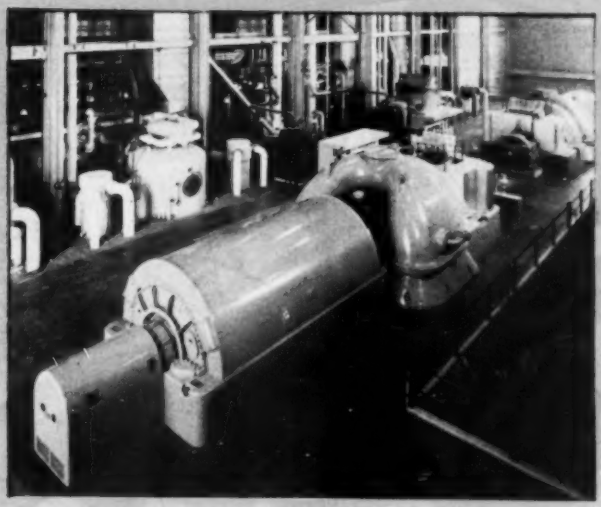


EXPANSION Hot water for this shower system flows 200 feet. To make proper expansion loops with rigid piping would be a plumber's nightmare of joints! The simple solution: easily installed American Flexible Metal Connectors. They allow for ample expansion and readily handle required pressure. They may be also used to carry steam, oil, syrups, solvents and even certain semisolids.

ANACONDA

wherever connectors must move *American* flexible metal hose and tubing

"Through performance alone... inhibited turbine oils have won preference among major utility operators"



...and here's why so many of them choose SHELL TURBO OIL

Shell Turbo Oil exceeds every accepted specification for premium turbine lubricants. These are the notable qualities:

1. HIGHEST ATTAINABLE RUST PROTECTION

An effective *combination* of rust inhibiting additives goes to work at the source of rust formation. Rust problems are reduced to the very lowest level.

2. COMPLETE OXIDATION STABILITY

The anti-oxidant in Shell Turbo Oil has so far defied improvement! It provides outstanding oxidation stability and thereby minimizes sludge formation.

3. ANTI-FOAMING

The anti-foam agent used is so effective that air entrainment can be tolerated for considerable periods—avoiding unscheduled shutdowns.

4. EXCELLENT EMULSION CHARACTERISTICS

Shell Turbo Oil's remarkable protection against rust and oxidation is attained with the minimum tendency to formation of water emulsions in service.

5. PROTECTION AGAINST WEAR

The inhibitive agents in Shell Turbo Oil *add* to the wear-reducing qualities of the specially refined oil itself, an extra margin of safety for the bearings during critical starting periods.

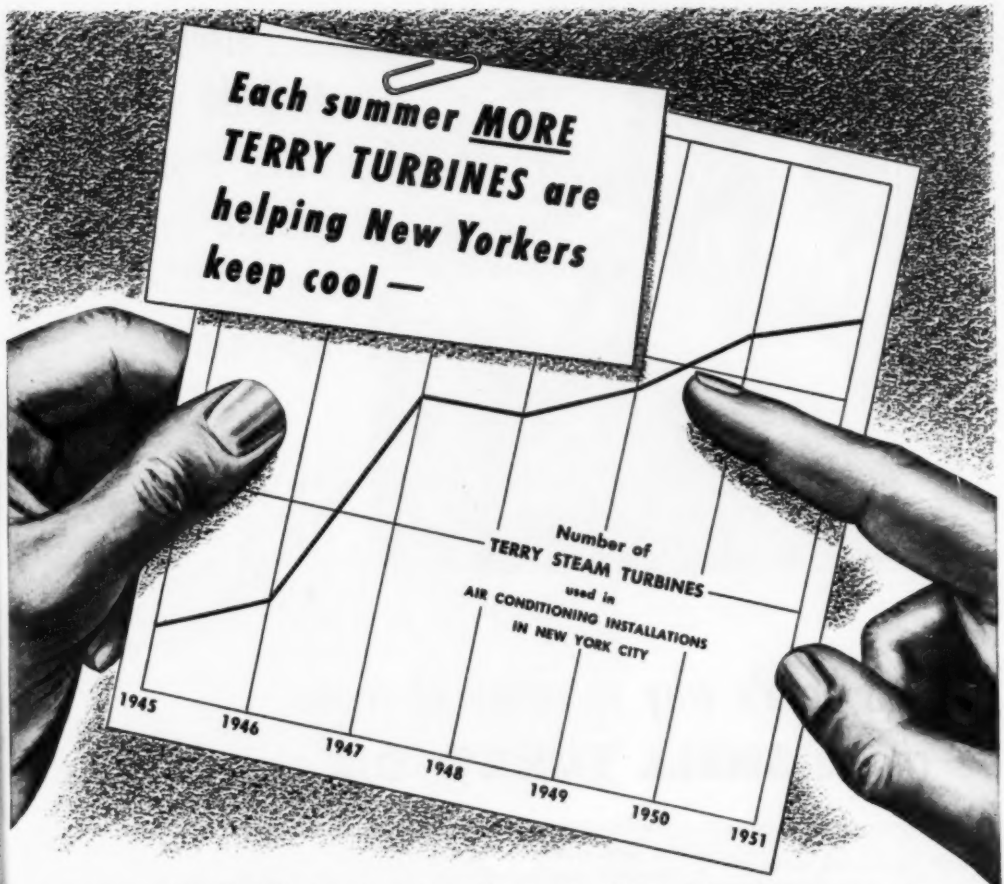
We'll be glad to give you the full story on Shell Turbo Oil, with specific recommendations for your own generating units.

SHELL OIL COMPANY

50 West 50th Street,
New York 20, New York,
or 100 Bush Street,
San Francisco 6, California.

SHELL

SHELL TURBO OIL



In recent years, New York City has witnessed a rapid gain in the number of air-conditioning installations providing comfort cooling by means of steam. And, as the accompanying chart shows, TERRY STEAM TURBINES have figured prominently in this relatively recent development.

TERRY TURBINES make an ideal prime mover for driving the refrigerating compressor. They respond automatically to the temperature requirements, and will cut back to as little as 15 percent of rating without attention. A Terry-designed unit assures economy and ease of operation.

Before you make a decision on your air-conditioning installation, why not call in a Terry representative? He will be glad to explain the benefits of *comfort cooling by steam.*

PARTIAL LIST OF TERRY TURBINE INSTALLATIONS IN NEW YORK CITY
Best & Co. • Bloomingdale Bros. • Book-of-the-Month Club Carbide & Carbon Building • Federal Reserve Bank • Lord & Taylor • Macy's New York • Madison Square Garden James McCreery & Co. • Mutual Life Insurance • Port Authority Bus Terminal • The 260 Madison Avenue Building

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1192

STOP RUST! with RUST-OLEUM

Every *rustable* metal surface needs **RUST-OLEUM**—the *exclusive* formula *proved* in all types of industry, at sea, above and below ground for over 25 years! Goes on easily by brush, dip or spray . . . dries to a *firm, elastic, decorative* finish that resists salt air, rain, snow, heat, fumes, smoke, etc. **RUST-OLEUM** may be applied *directly over surfaces already rusted without removing all the rust!* Simply scrape and wire-brush to remove rust scale and loose particles. Sandblasting and other costly preparations are not usually required. So easy to use that one man often does the work of two! Specify **RUST-OLEUM** to your contractor, architect or maintenance department. Prompt delivery from Industrial Distributor stocks in principal cities.

RUST-OLEUM CORPORATION
2473 Oakton Street • Evanston, Illinois

RUST-OLEUM BEAUTIFIES AS IT PROTECTS — AVAILABLE IN ALL COLORS, ALUMINUM AND WHITE

FREE SURVEY: Place your rust problems in the hands of a **RUST-OLEUM** specialist. He will conduct a survey, including *applications, specific tests,* and *recommendations. No cost or obligation.* See Sweets for catalog and nearest **RUST-OLEUM** distributor, or write for literature on your company letterhead.

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- ☐ Have a Qualified Representative Call.
- ☐ Full Details on FREE Survey.
- ☐ Complete Literature.
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TESTING TIPS for the maintenance of plant equipment

Lever Brothers Co. Cuts Testing Time 25% With Hook-on Wattmeter for Overload Tests

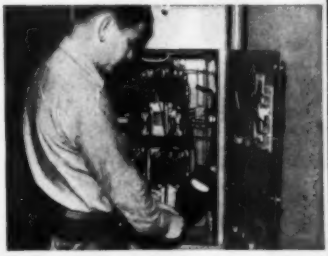
Lever Brothers Company, manufacturers of soap, edible products, and detergents, were able to cut testing time 25% by using the General Electric AK-2 hook-on wattmeter. They use the wattmeter to check power input in electrical equipment, and to check against overloads.

NO CUTTING OF CONDUCTORS

To measure power merely clamp the hook-on wattmeter around the line—no cutting of conductors, no costly shutdowns to make necessary power checks. Single-phase and polyphase circuits measured quickly and easily; in addition to kilowatts, vars in balanced three-phase circuits can be measured.

WIDE VERSATILITY

The AK-2 hook-on wattmeter can be used to make motor load tests, plant load surveys, to check resistance of electric furnaces, to measure kilowatts directly in overloaded areas, and in many other applications. The versatility of instrument is indicated by the fact that it will measure up to 300 KW, from 15-600 amperes, and from 100-600 volts—all at an accuracy of ± 5% full scale. Price: $87.00.* Order Bulletin GEC-591.



G-E Insulation-resistance Meter Cuts Rejections Due to Insulation Failure

REDUCTION OF REJECTS due to insulation failure is easily accomplished with a General Electric insulation-resistance meter.

SAFER TO OPERATE

Safer to operate, the maximum output current being limited to two milliamperes, the meter can be used wherever 115-volt, 50- or 60-cycle power is available. The meter measures insulating-resistance over a range of 0-20,000 megohms, and is extremely valuable in detecting faults during the manufacture of electrical equipment.

PREVENTATIVE TESTS NEEDED

By testing insulation-resistance before making high potential tests (which are essential in many production operations), you avoid destruction of electrical equipment that has faulty insulation. High potential tests will do this if insulation is poor. The insulation resistance meter is particularly useful in testing the insulation of plant equipment—thus providing for prompt performance of preventative maintenance, which in turn reduces costly production interruptions.

EASY TO USE

The G-E insulation-resistance meter is small, compact, portable—thus convenient for production and service testing. Operated by one person, the meter is simple to use. Price: $304.20.* Write for Bulletin GEC-753. General Electric Company, Schenectady 5, New York.

*Manufacturer's Suggested Retail Price.

GENERAL ELECTRIC

Pasadena Power and Light Praises G-E Portable Recorder Flexibility

Use of the General Electric CF-1 portable recorder by Pasadena Power & Light Co., has resulted in satisfactory voltage checks, reports A. Leonard Stevenson, relay tester.

REGULATORS CHECKED

Mr. Stevenson, shown in the photo above, says that regulator relays "are checked once a month to maintain standard voltages. Located in distribution centers for circuits, our CF-1's check the regulators to see that they are correctly compensated. The recorders are used whenever a circuit cut is made for adding or decreasing power. This instrument is more accurate than those previously used —its flexibility and adaptability make it a thoroughly satisfactory instrument."

30-DAY CHARTS AVAILABLE

You can get accurate records over an extended period of time with a G-E Type CF inkless recorder. Designed for dependability and maximum convenience, it can run as long as 30 days without attention, and has a weather seal for outdoor service. Simply put it on the line; it records volts, amps, or single-phase watts—just the information you need to determine what corrective action is necessary. The CF inkless recorder has an accuracy up to ± 1½ per cent of full scale value. Price of voltmeter (0-140/280 volts): $110.00.* More details in GEC-215.

When ordering bulletins, write to Section 602-239, General Electric Company, Schenectady, N. Y.

BUY NOW

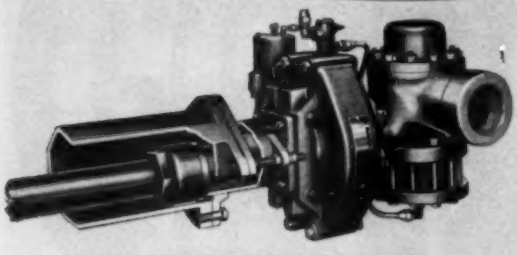
From Your Nearest G-E Distributor

DIAMOND "AIR PUFF" SOOT BLOWING IS AUTOMATIC

MOTORIZED
SELECTIVE
SEQUENTIAL

plus

SIMPLICITY
LOW COST



Diamond "Air Puff" Soot Blower has multi-nozzle element permanently installed inside setting. Compressed air is discharged in measured short puffs with pauses between. The air motor rotates the element during puff . . . stops during intervals while original air pressure is restored. Air waste avoided by confining blowing time to period when pressure is high enough to be effective.

Master Controller which automatically controls all Diamond "Air Puff" Soot Blowers in system. Automatic . . . just a twist of the wrist and the controller does the rest. Controls puff duration and interval, regulates element rotation, opens and closes air valve in head, and determines sequence.

The most effective and economical means for automatic cleaning of small and medium sized boilers is usually the Diamond "Air Puff" Soot Blower System. It is an automatic sequential system . . . the engineer merely actuates the control to start. The compact, versatile controller operates each blower correctly and in proper sequence . . . then shuts off at completion. The blowing air is used for all functions . . . blowing . . . rotating the blowing element . . . and actuating the controller. No other source of power or energy is required. Compressed air is supplied by a relatively small compressor-receiver unit because of "Air Puff" (measured interval) blowing.

Simple, inexpensive, effective, the Diamond "Air Puff" System does a remarkable job at low cost. Cleaning by air puff is more efficient . . . requires less installation and maintenance expense.

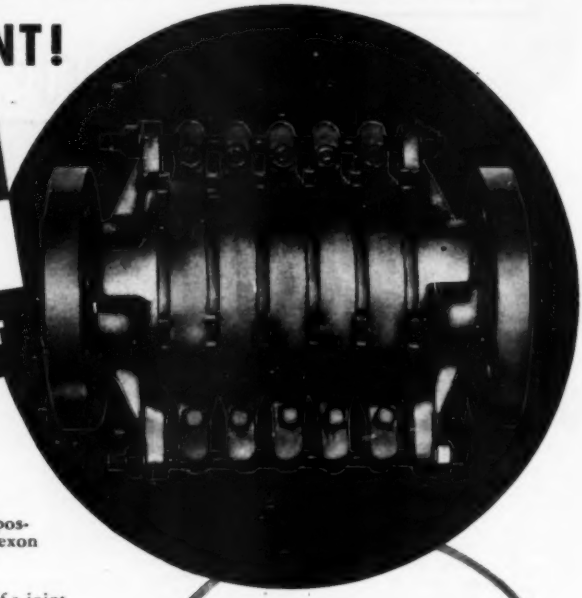
DIAMOND POWER SPECIALTY CORPORATION
LANCASTER, OHIO
Diamond Specialty Limited—Windsor, Ontario

Now you can have GREATER PIPE LINE MOTION CONTROL IN A MORE COMPACT, LESS COSTLY EXPANSION JOINT!

THE NEW

FLEXON

EXPANSION JOINT



Continuing research and development at Flexonics Corporation have now made it possible to offer design improvements in Flexon Expansion Joints that provide three basic advantages:

1. The face-to-face (over-all) dimension of a joint to handle a given amount of expansion has been reduced.
2. The reduction in size results in a lower expansion joint cost to handle a given amount of motion.
3. Exhaustive tests prove that these joints provide a maximum of motion commensurate with optimum life.

Coupled with such accepted advantages as compactness, ease of installation and freedom from maintenance, these additional advantages make Flexon Expansion Joints the most satisfactory method of controlling pipe line motion for the majority of installations.

Complete specifications are given in the new Flexon Expansion Joint Bulletin. Check this data before you select or specify expansion joints for your plant. Write for your copy, today.

THREE TYPES AVAILABLE

FREE FLEXING—Available in sizes from 3" through 48" I.D. in copper or stainless steel. Suitable for pressures to 30 psi, temperatures from minus 100°F. to 800°F.

CONTROLLED FLEXING—(Illustrated above) Available in sizes from 3" through 48" I.D. in copper or stainless steel. Suitable for pressures to 300 psi, temperatures from minus 100°F. to 800°F.

FLEXONIFLEX—Integral ring type. Available in sizes from ½" pipe through 6" pipe. Suitable for pressures to 5500 psi, temperatures from minus 400°F. to 1600°F.

Flexonics *Corporation* **EXPANSION JOINT DIVISION**
1335 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 30 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

CHROMALOX

combining Heater and Thermostat in one unit

ready to go on your Jobs!

● CHROMALOX 'Packaged' Electric Heaters are ideal as permanent or portable heat sources in tanks, drums, process kettles and other containers. With CHROMALOX Heaters you can heat accurately and maintain the temperature of degreasing, cleaning, pickling and plating baths. You can melt greases, asphalt and similar viscous fluids. CHROMALOX Units may be had in the types, sizes and wattages required to efficiently do your heating jobs. They are available with sheaths of copper, stainless steel, alloy and lead for resisting the corrosive actions of the solutions you are using.

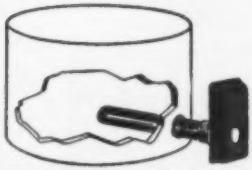
Nation-wide engineering service for on-the-job assistance and recommendations. Write, wire or phone for the name of the Chromalox Engineering Representative serving you.

CHROMALOX

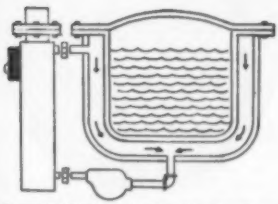
Electric Heat for Modern Industry

Variety and Versatility to fit your Needs Exactly

Chromalox Immersion Heaters with built-in thermostats for portable or permanent use. Drawing Illustrates Immersion Units, equipped with sludge-legs, installed over the side of the tank for direct heating. Available in various metal sheaths to resist the corrosive action of the liquid compounds.



Compact, thermostatically controlled, screw-in type Chromalox Immersion Unit is easily installed in smaller tanks and other containers. Thermostat range is 100° to 180° F.



Chromalox Circulation Heaters give accurate, controlled heat up to 750° F. for heating Dowtherm, Aroclor or heat transfer oils. Other uses include water heating applications such as steam boilers and accumulators, kettles, tanks and processing equipment, preheating fuel oils, heating air, nitrogen and other gases; drying steam, plastic powders, etc.

Clip Coupon

For complete details showing how to use Chromalox Heaters in your applications.

Industrial Division IC-84
EDWIN L. WIEGAND COMPANY
7520 Thomas Boulevard, Pittsburgh 8, Pa.

Please send "100 Ways to Apply Electric Heat" booklet.

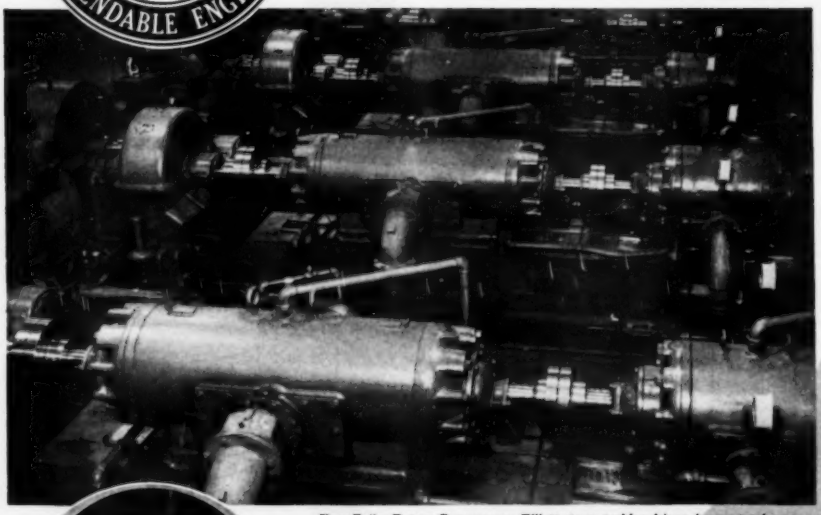
Name_____

Address_____

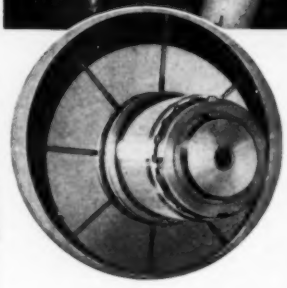
City_____ Zone____

State_____

PRATT & WHITNEY AIRCRAFT



Four Fuller Rotary Compressors, Elliott steam-turbine driven, have a total capacity of 6760 c.f.m., at 110 p.s.i.



depends on FULLER AIRPOWER

Four Fuller Rotary Two-stage Compressors put Pratt & Whitney Aircraft's engine plant in East Hartford on a 100 p.s.i. air diet for such operations as shot peening, spray booths, air cleaning, and air-operated chucks.

Pratt & Whitney Aircraft has joined no *small* family of users; food and chemical plants, steel mills and cement mills, gas-gathering plants, refineries, automobile plants, foundries and machine shops, public utilities, and many others depend on Fuller for compressor equipment, wherever air is required.

Whether *your* air-plans call for single-stage, two-stage — single-stage duplex or two-stage duplex—you can be sure Fuller has the compressors which gives you a dependable source of pulsation-free air up to 3300 c.f.m., 125 p.s.i., with maintained capacity for the life of the machine.

Write for Bulletin C-6, Fuller Rotary Compressors.

FULLER COMPANY, Catasauqua, Pa.
Chicago 3—120 So. LaSalle St.
San Francisco 4—420 Chancery Bldg.

Fuller

PIONEERS OF HIGH-EFFICIENCY VANE-TYPE ROTARY COMPRESSORS

C-225
1624

QUAKER *Production-eered** BELTING

ON THE DRIVE FOR 10 YEARS ...AND LIFE JUST BEGINS

QUAKER TRANSMISSION BELT

"HOLDS UP TWICE AS LONG ON MAIN DRIVE AS ANY OTHER BELT"

On the job more than 10 years—six of them running day and night. Delivery peak power, production and performance . . . demanding virtually no maintenance at all! That's the powerful record built up by this tireless Ironsides Endless transmission belt "Production-eered" by QUAKER for a Southern mill.

Through the years, this faithful QUAKER belt has harnessed the horsepower of this big main drive . . . delivering smooth, silent, positive power. And still no signs of wear or tear! Says the production superintendent: "We find Quaker belting holds up twice as long as any other belting. We are now using a belt that's as good as the day we put it on . . ."

Just one more example of QUAKER "Production-eering" at work. Let an experienced QUAKER "Production-eer" help you boost production, cut costs with QUAKER "Production-eered" belting, hose, packing and molded rubber products.

***Production-eering**—Every Quaker Industrial Rubber Product is "Production-eered"—engineered to provide maximum life, efficiency and production on each type of installation. Quaker "Production-eers" are ready to recommend the right rubber product for the job. For timely production tips get the new free booklet on "Production-eering for Industry." Write today.

Get This Book

QUAKER RUBBER CORPORATION

DIVISION OF H. K. PORTER COMPANY, INC.

PHILADELPHIA 24, PA. · BRANCHES IN PRINCIPAL CITIES

Tough Guy!

and his number is

CHAPMAN

List 960

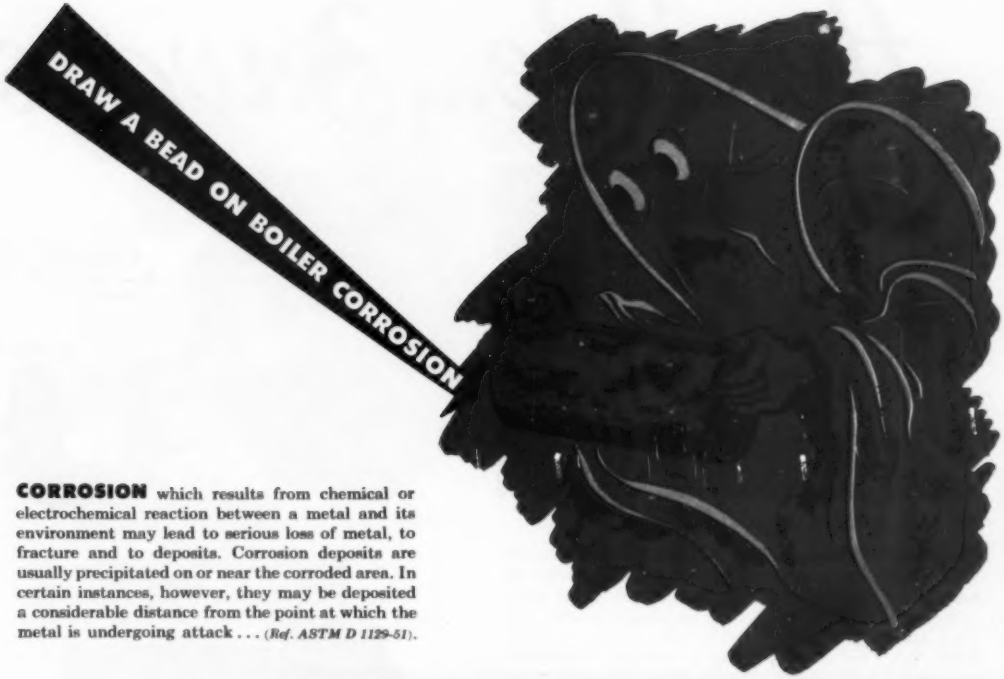
Tough — that's the word for this small Chapman Gate Valve with the forged steel body and yoke. For no matter what job you put it on, within its remarkable capacity-range, you'll find it *tougher than the toughest conditions!*

That's right, *tougher* . . . because seat rings are hardened stainless steel . . . because wedge-faces are *superhardened* by Chapman's exclusive Malcomizing Process . . . and because the stem and wedge gate connection has been given extra strength to meet any extra stress.

So no matter what your job for small forged steel gate valves, Chapman's List 960 is the one you can bet on to "lick all comers." You can get it in sizes from ½" to 2" . . . equipped with rising stem, either with yoke as shown, or with inside screw. Bonnet joints are gasketed or metal-to-metal. Pressure range: 2,000 lb. at 100° F., to 380 lb. at 1,000° F. For higher pressures, specifyList 990. Write for Catalog No. 10.

The CHAPMAN Valve Mfg. Co.

INDIAN ORCHARD, MASSACHUSETTS



CORROSION which results from chemical or electrochemical reaction between a metal and its environment may lead to serious loss of metal, to fracture and to deposits. Corrosion deposits are usually precipitated on or near the corroded area. In certain instances, however, they may be deposited a considerable distance from the point at which the metal is undergoing attack . . . *(Ref. ASTM D 1129-51).*

Use DREW POWER CHEMICALS

Corrosion may be active in your boiler water system now—ready to cause expensive trouble in boilers, steam and condensate lines. Serious deposits may result from corrosion. It's time now to inspect your boiler system thoroughly, to avoid inconvenience—even plant shutdown.

So, draw a bead on boiler system corrosion, Mr. Engineer. Call for the Drew Power Chemicals Engineer. The water samples and operating data he obtains in your plant will be thoroughly analyzed in the Drew Laboratories. You'll be given specific recommendations for corrective or preventive treatment. Furthermore, your Drew Engineer will give you frequent and continuous help in your plant.

Thorough investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies. Consult the nearest Drew Engineer, or write for information.

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

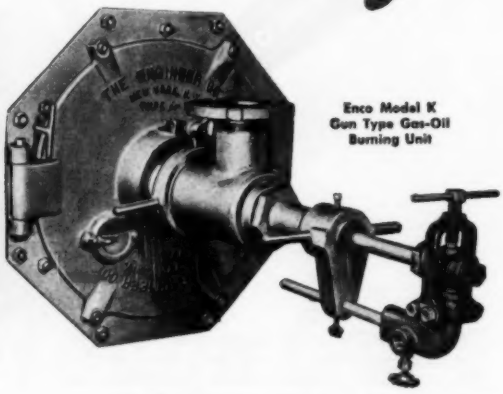
SAN FRANCISCO CHICAGO AJAX, ONTARIO PHILADELPHIA BOSTON DALLAS

Service throughout the United States, Canada and South America

DREW PRODUCTS

flexible... 3 ways

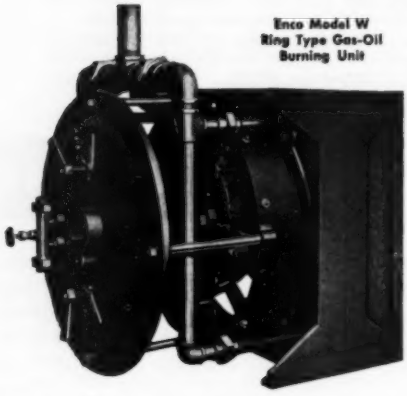
ENCO
OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.



Enco Model W
Ring Type Gas-Oil
Burning Unit

ENCO
INTERCHANGEABLE ATOMIZERS
FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

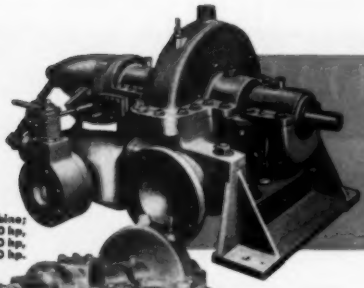
Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

Enco Standard Range Mechanical Atomizer Gun
Enco Wide Range Steam Atomizer Gun
Enco Wide Range Mechanical Atomizer Gun
Enco Standard Atomizer Gun Support
Enco Gas Burning Gun

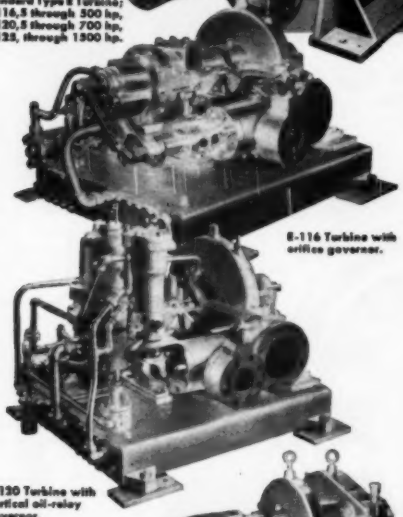
FC-488

THE ENGINEER COMPANY
75 WEST STREET, NEW YORK 6, N. Y.

Take the *Guesswork* out of Turbine Selection!

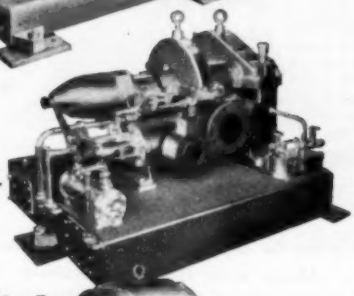


Standard Type E Turbine;
E-116, 5 through 300 hp,
E-120, 5 through 700 hp,
E-122, through 1500 hp.

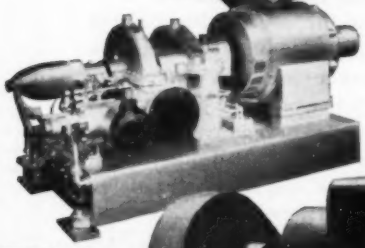


E-116 Turbine with orifice governor.

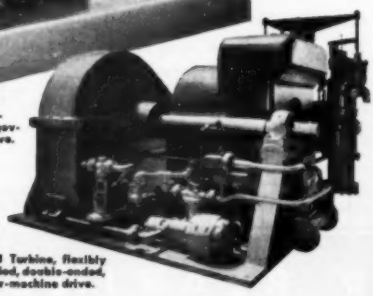
E-120 Turbine with vertical oil-relay governor.



E-116 Turbine, close-coupled gear; shaft governor.



E-120 Turbine, close-coupled gear; shaft governor—generator drive.



M-22 Turbine, flexibly coupled, double-ended, paper-machine drive.

Westinghouse General-Purpose Turbines can be supplied for mechanical or generator drive . . . either direct connected or geared . . . for condensing or noncondensing operation. This *complete* line . . . plus a nationwide staff of trained steam engineers, conveniently located sales offices, and service shops . . . assures you of the correct solution to *your* steam-drive application problem.

The single-stage Type E turbine, with designs for three basic classes of steam conditions, three wheel sizes and three standard governor types, provides in effect twenty-seven *standard, economical* variations to cover a wide range of applications. In addition, an almost limitless number of special applications can be met through the use of heavy-duty parts, and optional accessories.

Geared-turbine drives are offered either flexibly coupled to accommodate either right- or left-hand gear offsets, double-ended output shafts; or close-coupled (Gearturbines). Gearturbines are standardized on a single offset arrangement, affording utmost economy.

Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multi-stage units for applications requiring high temperatures and pressures, higher speeds, greater horsepower, extraction for process applications, or higher efficiency than may be had with single-stage machines.

The superiority of the Westinghouse line is the result of over 60-years' design, manufacture, and application experience. To get the benefit of this broad know-how, call your nearby Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

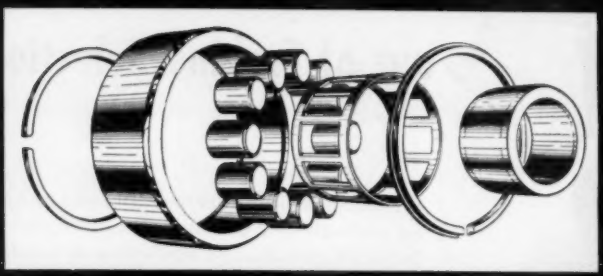
J-50532

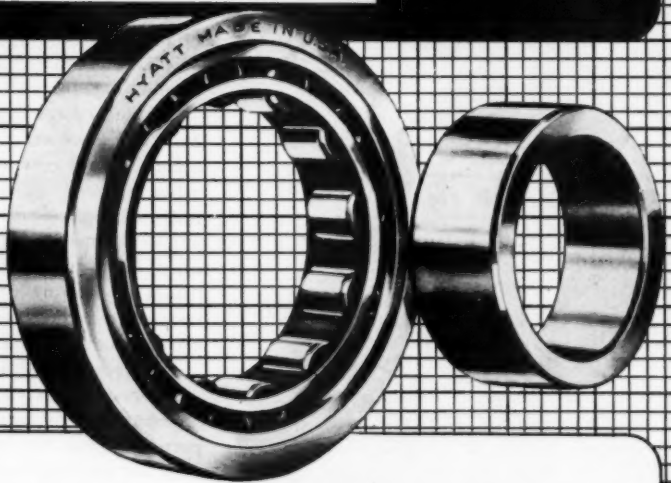
YOU CAN BE SURE... IF IT'S

Westinghouse

GENERAL-PURPOSE TURBINES

HYATT HY-LOADS . . . for Capacity Separability and Long Life





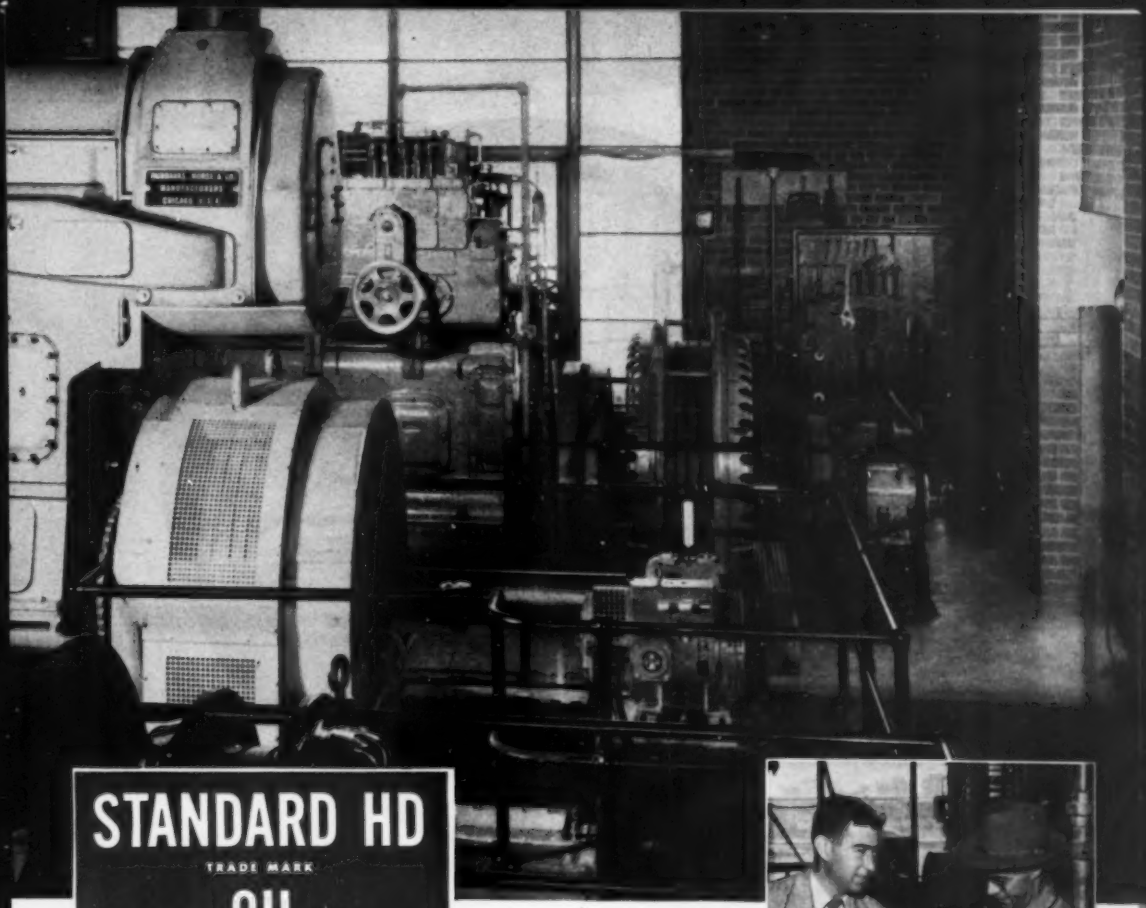
IN THE family of Hyatt Hy-Load Roller Bearings is the popular A-TS type, one of the separable inner race, high-capacity cylindrical roller bearings made in two diameter series, wide and narrow widths, to standard boundary dimensions.

Separable parts are freely interchangeable. Any inner race will fit any roller assembly of the same piece number, permitting non-selective fitting after preassembling the two bearing parts in separable machine elements.

Along with their well-known load-carrying capacity, separability features and long life, Hyatt Roller Bearings also assure smoother operation, less maintenance and better machine design.

We will be glad to send you literature covering Hy-Loads and all other Hyatt Roller Bearings. Ask for Hyatt Catalog 150. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



STANDARD HD
TRADE MARK
OIL

Solves a fuel problem...

● The Center Municipal Power Plant of Center, Colorado, had a unique fuel problem. Because of the plant's rather remote location in the Rocky Mountains, the cost of transporting diesel fuel to the plant was extremely high. Resourceful Mr. Vail F. Shumaker, superintendent, worked out a plan for utilizing locally produced crude oil as a fuel. The poor burning quality of this fuel, however, led to trouble. Fuel soot was heavy and deposits formed in the plant's four engines. Rings began sticking.

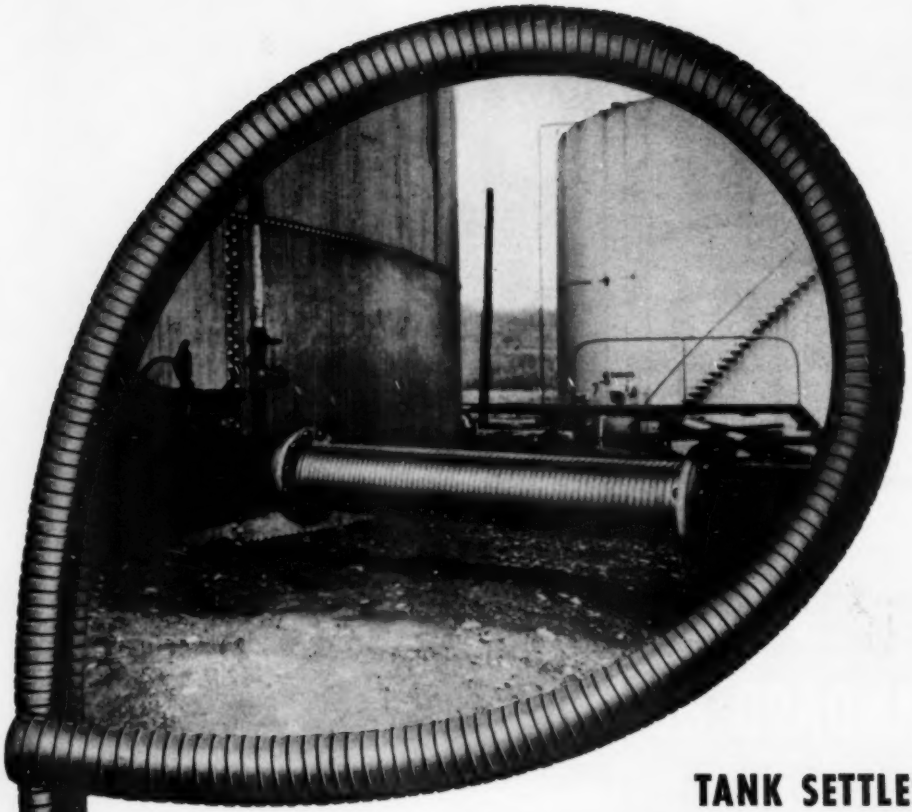
A Standard Oil lubrication specialist was asked for advice. Upon his suggestion, the conventional lubricant used in the diesels was replaced in one engine by STANDARD HD Oil, a truly heavy-duty lubricant containing necessary additives. During the next few months' operation, this engine alone remained clean. It was evidence enough. The other diesels were switched to STANDARD HD. Despite severe operating conditions imposed by the poor burning fuel, STANDARD HD has kept these engines clean and protected during three years of service. It has made possible the use of the locally available fuel and thus effected a sizable saving for this power plant.

This plant's experience indicates how you can benefit through STANDARD HD and the services of a Standard Oil lubrication specialist. You can get those services easily and quickly by phoning your local Standard Oil (Indiana) office. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

Pleased with performance of STANDARD HD oil are J. J. Tyler of Standard Oil (left) and Vail F. Shumaker, Superintendent of Center, Colorado, Municipal Power Plant, who worked closely together to solve a unique fuel-lubrication problem.

STANDARD OIL COMPANY

STANDARD *(Indiana)*



TANK SETTLES . . .

PIPE WALKS . . . BREAK AVOIDED WITH PENFLEX

Tank settlement . . . thermal expansion and contraction caused misalignment of pipe and the consequent breakage of rigid pipe connections on large oil storage tanks. Oil and gasoline was lost . . . a fire hazard was ever present. The answer was offered by Penflex engineers.

Today, this large New England storage center has no trouble with pipe breakage. A length of 12" I.D., four-wall interlocked specially packed Penflex tubing was installed with tight-packed flanges. No amount of settling of the tank or thermal expansion causes breakage of connections. The easy flexing Penflex "walks" with the tank . . . yet maintains a tight leak-proof connection at all times. Leakage has been eliminated . . . fire hazard reduced.

Let Penflex engineers help you on flexible tubing application problems. Penflex manufacturers a complete line of four wall, interlocking and seamless welded corrugated flexible tubing . . . metallic hose, tubing or couplings from ⅛" I.D. and up . . . automatic barrel fillers, pneumatic rivet passers, accessories and fittings. Write for folder "Flexineering," a valuable production aid.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7238 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

penflex

HEART OF INDUSTRY'S LIFE LINES

Lubricate with "dag" Dispersions . . . Reduce Friction . . . Resist Heat

At virtually all temperatures experienced in hot-metal work **"dag"** colloidal graphite dispersions reduce friction to a minimum . . . keep work lubricated . . . protect metal. For brass, bronze, aluminum, magnesium, carbon steel and stainless steel . . . wherever your forming problems are friction and heat . . . **"dag"** colloidal graphite reduces one and resists the other.

Use **"dag"** dispersions:

in *wire drawing*—to assure longer die life and uniform dimensions

in *deep piercing*—to produce smooth forgings to close tolerances, reduce die damage

in *casting and mold stripping*—to insure smooth surfaces and clean parting

in *forging*—to minimize scaling and sticking, improve finish, lengthen die life

in *stretch forming*—to reduce tearing and rippling.

When **"dag"** colloidal graphite is applied to friction surfaces, it leaves a dry film that gives the metal surface an extremely low coefficient of friction, that resists oxidation, that functions far above the burning-point of conventional petroleum lubricants.

Write TODAY for your free copy of "Use of Colloidal Graphite for Metalworking Operations." Ask for Bulletin No. 426-17H.

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Acheson Colloids Company, Port Huron, Mich.

. . . also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

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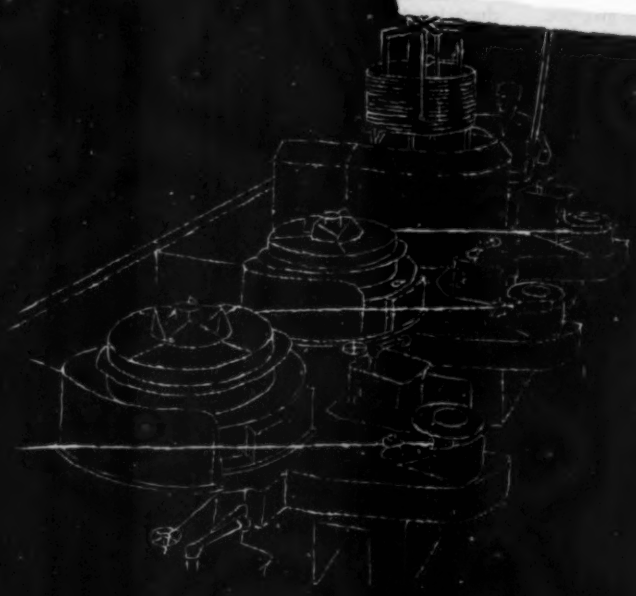

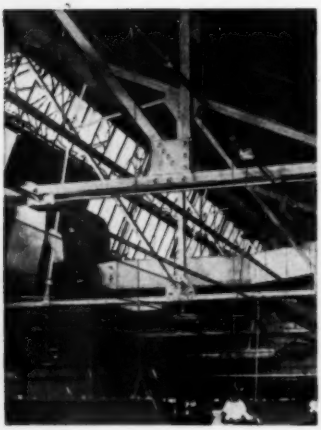

Fresh Air is introduced through the saw-tooth. Torridor warms this air quickly and delivers it through ductwork.

Employees Stay Warm and draft-free in this production area, warmed by Torridor inverted ceiling type unit.

Torridors Kill Drafts at the doors to this covered track, get warmth right down to the loading dock.

How you can "tailor" TRANE torridors to fit your special heating problems

THINK of a *tough* heating job—where you need a big volume of warmed air. Then take a TRANE Torridor with the needed fan capacity. Add to it the exact amount of heating surface the job calls for, the motor with the right horsepower, the most economical drive, the most efficient controls. Result: you have actually "tailored" this one unit heater to handle your heating job perfectly . . . and it doesn't cost you one cent extra!

That's because TRANE Torridors give you an *unmatched choice* of component parts. You can select from 5 basic models, 10 cabinet sizes and a wide range of motors, filters, controls, dampers and heating coils. Motor or direct drive; 2, 3 or 4 outlets. Thus you can specify the *exact* unit for your job.

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This versatility and freedom of choice is characteristic of the full TRANE line of unit heaters. *Six different types* for every unit heater job. Prompt delivery on current orders. See your nearest TRANE sales engineer or write for Bulletin DS-327A.

TRANE Projection Heater with Louver Cone Diffuser gives 60% greater heat-throw.

TRANE Model H Unit Heater with Louver Fin Diffuser does the work of *two* units.

TRANE Float Trap (shown), Bucket and Thermostatic Traps give perfect results with TRANE Unit Heaters.

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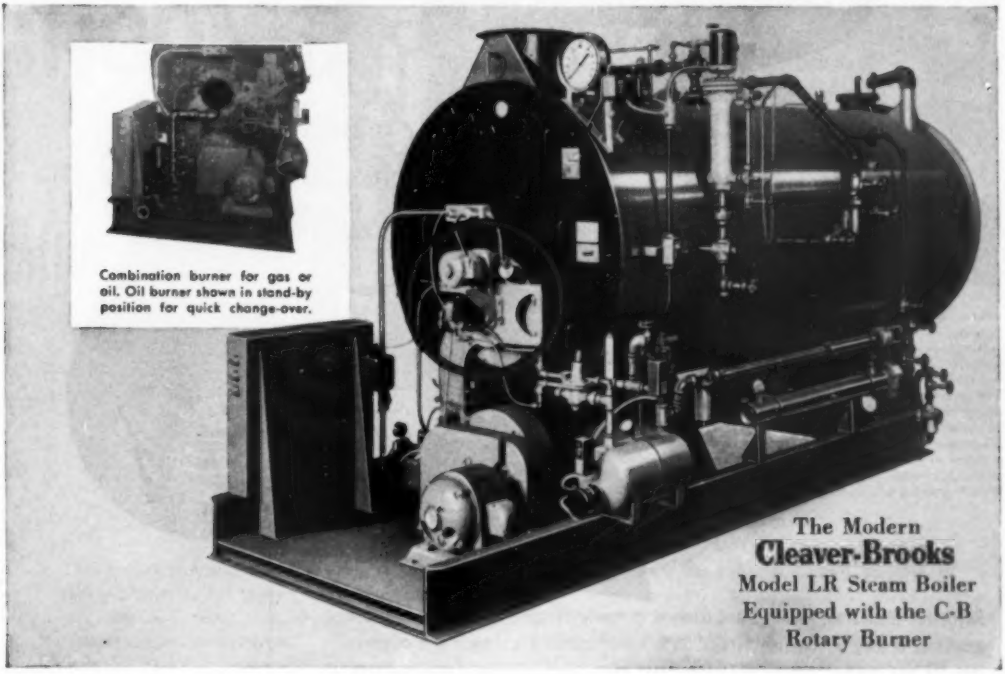
unmatched Flexibility of operation ...and of quick fuel change-over


Combination burner for gas or oil. Oil burner shown in stand-by position for quick change-over.
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Cleaver-Brooks
Model LR Steam Boiler
Equipped with the C-B
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✓ **Quick Steaming—Fast, effortless response to fluctuating steam demands**

✓ **Equally high efficiency using heavy No. 6 oils (or lighter oils) and all types of industrial gas**

IF the quantity of steam required in your plant fluctuates throughout the day, depending upon the amount of steam-using equipment in operation, you can cut your steam costs substantially with a Cleaver-Brooks Boiler. It operates a full 80% guaranteed efficiency whether you require maximum load use of all steam-using equipment . . . or whether your equipment is not in use, requiring as little as 30% response—often just enough to heat the plant.

Install a Cleaver-Brooks Boiler — oil, gas, or combination — either fuel properly proportioned by the exclusive Cleaver-Brooks Burner to meet your fluctuating or constant steam demand. Fully automatic, clean, with a single source for all of its matched parts . . . you benefit with lower fuel bills, less maintenance, reduced operating costs, greater profits. Why not consider changing your present boiler plant and think of flexibility — remember Cleaver-Brooks and get the complete facts on boilers, 15 to 500 HP — 15 to 250 lbs. psi.

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Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

IT'S PACKED WITH SATISFACTION WHEN IT'S PACKED WITH **R/M**

Raybestos-Manhattan Packings and Gaskets, properly installed in your valves, are assurance of long trouble-free service. R/M manufactures a complete line of packings for use against steam, oil, water, gas, beer, acids, alkalies, brine, hydraulic fluids and practically every other commercial fluid. The R/M distributor near you will be glad to help you in selecting the right packings for your equipment.

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INCONEL...

the heat-resisting alloy for a plant's severest hot spots

★ ★ ★

This "water-back" is one of two used in boilers at Toledo Edison's Acme Plant. Made of ¼-inch Inconel plate, these devices are used to break up and cool molten slag as it slides down the division wall between fire and tube sections of the boiler. One side of the plate is subjected to the 2200° to 2400° F. radiant heat of the molten slag, while a spray of cooling water plays on the reverse side. Thermal shock and abrasion are so great that only a tough, high-strength, high-temperature material like Inconel can survive for long. Previously used materials lasted only three months. Yet Inconel gave 18 months of service —and they went out only after the water spray headers (shown under Inconel Cap sheet) clogged and shut off the cooling water.

This versatile wrought-nickel alloy is serving in many places in the power field where its extra strength and resistance to oxidation at high temperatures are essential.

Inconel® is a structurally stable alloy that does not lose its toughness even after long exposure to high temperatures. It is particularly useful for services involving cyclic heating and cooling, or thermal shock.

Inconel has high impact strength, too. Charpy tests reveal strength of 154 ft.-lbs. at 1400° F.

And its resistance to relaxation or load loss makes it an excellent metal for springs where operating temperatures range from 500° to 650° F.

You'll find that Inconel is workable both hot and cold. It is machinable and can be joined by the usual welding, brazing and soldering processes.

You can get all the essential engineering data on Inconel from Technical Bulletin T-7, "Engineering Properties of Inconel." Write for your free copy today.

And remember, Inconel, like other nickel alloys, is on extended delivery because of defense. Therefore, it is important to include your NPA rating and complete end-use information with all orders.

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Nickel INCO Alloys

MONEL® • "S"® MONEL • "K"® MONEL
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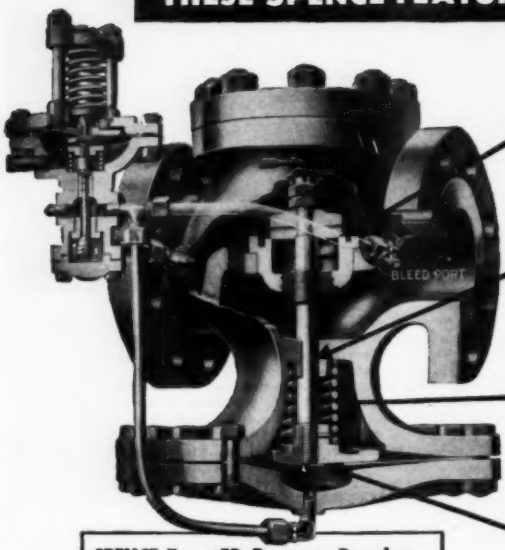
HERE'S PROOF

You Can Cut Costs of Pressure and Temperature Control

THESE SPENCE FEATURES SHOW YOU HOW



SPENCE Type ED Pressure Regulator

SECO METAL, SEATS AND DISCS — Durable SECO Metal resists wiredrawing. *More than twenty years of experience* in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

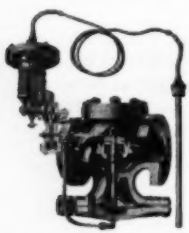
PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

SPRING OUT OF PATH OF STEAM — The spring in the Spence Regulator is out of the path of the steam or other fluid flowing through the valve. It operates at low unit stress for exceptionally long life.

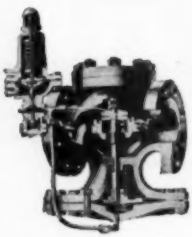
LARGE BALANCED DIAPHRAGM—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.

YOU BENEFIT by these and many other Spence features that assure *accurate, dependable* regulation year after year. That means *less down-time, less time and money wasted on replacement of parts.*

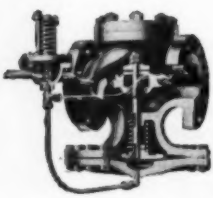
Spence Pressure and Temperature Regulators are built in sizes from *¼" to 12"* for service with *air, steam, water, oil or gas.* Only minor adjustments are needed to switch any Spence Regulator from one service to another.



Type BT150 Temperature Regulator—Tops in performance for both storage and instantaneous heaters.



Type EN Differential Regulator—Accurately controls differential between fluid delivered by regulator and some other source of pressure connected to the pilot spring chamber.



Type EQ Back Pressure Regulator — Completely packless, pilot operated for accurate control of the initial pressure.

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The Atlantic Refining Company
Great Lakes Steel Corporation
Todd Shipyards Corporation
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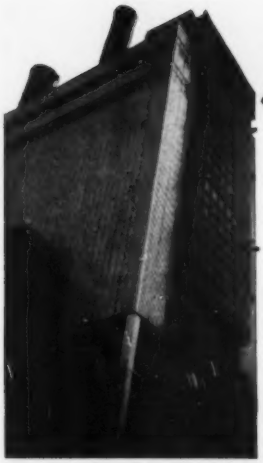
General Electric Company
R. J. Reynolds Tobacco Company
Ohio Edison Company

and thousands of others

SPENCE ENGINEERING COMPANY INC.
WALDEN, NEW YORK

Spence



Keeping Pace With Modern Boiler Design...

One Material Insulates The Entire Job-Better

New boiler installation by Babcock & Wilcox Company, an extension of Toledo Edison Company's Acme Plant, has a rated steam output of 650,000 lb. per hr. at 1500 psi. pressure and 1000°F. temperature. The new boiler is the largest in northwestern Ohio.

Kaylo Heat Insulation—the first basic advancement in the insulating industry in many years—is a hydrous calcium silicate. This remarkable inorganic material (not glass) provides a combination of far-reaching advantages.

With its wide effective temperature range—up to 1200°F.—Kaylo Heat Insulation eliminates the need for combination coverings in nearly all operating conditions. It retains its efficiency and dimensional stability in long service.

Kaylo Heat Insulation is insoluble in water. Its high strength practically eliminates spoilage both in transit and in application. Workmen can walk on insulated equipment without breakage. Yet along with its high strength Kaylo Heat Insulation is light in weight, making it easy to handle and apply.

For complete details on Kaylo Heat Insulation, write Dept. N-312, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO HEAT INSULATING BLOCK is made in all standard sizes, up to 18″ wide and in thicknesses from 1″ to 6″. Where necessary, on special order, the block can be shiplapped for broken joint, single-layer application in thicknesses of 3″ or greater.

KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters for snug nesting, when needed. Coverings are sectional for tube and pipe sizes ¼″ to 12″; tri-segmental up to 23″; quad-segmental up to 41″; K-segmental (18″ wide segments) up to 72″ in diameter.

KAYLO ... *first in calcium silicate*

SEND FOR OUR CATALOG

...pioneered by OWENS-ILLINOIS Glass Company

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DETROIT • HOUSTON • MINNEAPOLIS • NEW YORK • OKLAHOMA CITY • PHILADELPHIA • PITTSBURGH • ST. LOUIS • WASHINGTON

Aid for "Dry" Communities ... Relief from High Water Bills

Many industrial plants have solved the scarce-water problem by using raw river or lake water for plant services.

Passing such water through a Cuno FLO-KLEAN effectively strains out trash and cleans the water at rates up to 20,000 gpm, with negligible pressure drop.

Other plants use FLO-KLEAN for reclaiming used process water. Even when water isn't scarce, it still costs money, particularly if it has been heated for process work.

On this basis, Cuno FLO-KLEANS have paid for themselves in as short a time as six months.

They even reclaim their own backwash water—not wasting a drop!

Continuously Cleanable Permanent

The Cuno FLO-KLEAN positively removes all solids larger than specified. May be specified from .030 in. down to .0025 in. Operation is continuous—because the strainer is continuously self-cleaning. Therefore, full flow can be handled without needing a duplex installation.

With continuous backwash cleaning of the cartridge and automatic top and bottom blow-down, the FLO-KLEAN needs no attention.

All-metal construction is abrasive and corrosion-resistant.

Cuno Engineering Corporation
Dept. 1418, South Vine Street, Meriden, Conn.

Please send information on Cuno FLO-KLEAN for straining raw water....reclaiming process water....

Name.....Title.....

Company.....

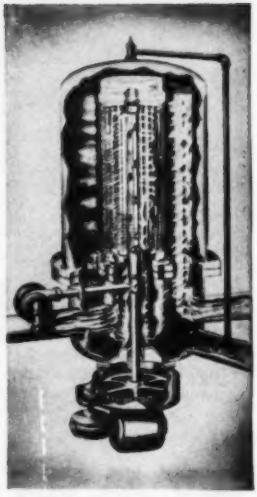
Address.....

City.....Zone....State....

Please attach to business letterhead

Clean Raw Water
Reclaim Process Water
with this low-cost non-stop strainer

Abrasion and corrosion-resistant Cuno FLO-KLEAN handles full flow—cleans itself and discharges accumulated trash *without interrupting* flow. Can be installed in some remote place and forgotten. Some users have saved enough to pay cost of FLO-KLEAN in a few months!



CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
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Clean raw water, recirculating water, etc.—FLO-KLEAN

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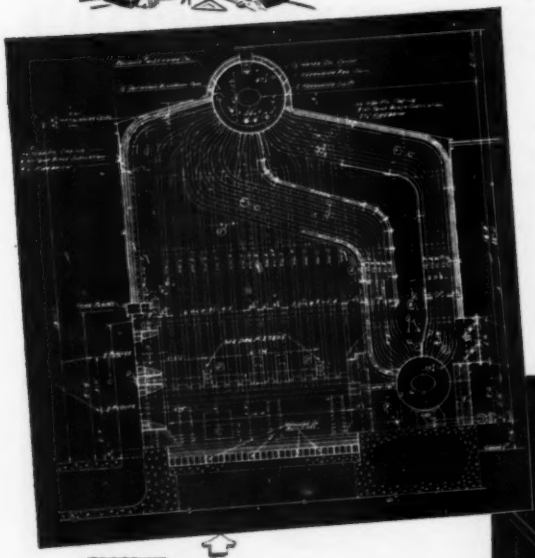
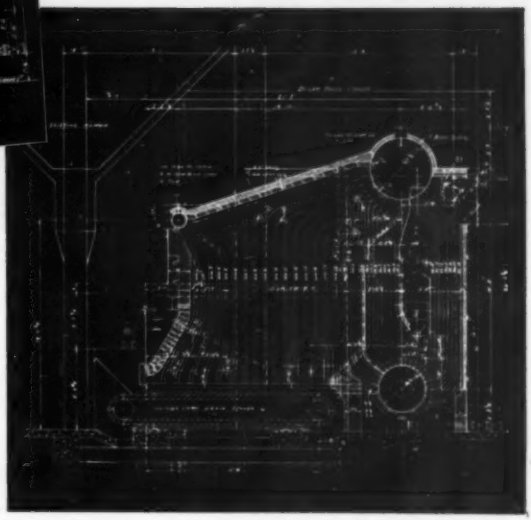


Two-Drum
STEAM GENERATORS
by Vogt

CLASS VF
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



CLASS VS
The Seelbach Hotel, Louisville, Ky. is served by this 50,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

A bulletin with general information and showing typical installations is available on request.

Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

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HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

steam trap trial shows how to increase production

Flat-work ironers in Pennsylvania laundry heat up in 15 min. with Yarway traps instead of previous 1½ hours.

West Coast Rubber molding plant cut heating cycle on presses from 15 minutes to 8 minutes by using Yarway traps.

Kettles in New England hospital kitchen reach cooking temperature in 12 minutes with Yarways instead of previous 25 minutes.

Southern textile mill gets satisfactory dasher production for first time due to faster heating-up with Yarway traps.

These 4 plants—each in a different industry—have something in common. Each installed a Yarway Impulse Steam Trap on a trial basis—and after witnessing the production-boosting results, they standardized on Yarway traps.

Experiences like these are found in hundreds of plants because Yarways are *designed* to get equipment *hot in a hurry*, and therefore into production fast.

Coupled with other Yarway Impulse Steam Trap advantages like small size, easy installation, stainless steel construction, easy maintenance and low cost—it explains why more than 800,000 Yarways have already been installed.

YARWAY

the steam trap designed with more production in mind

YARNALL-WARING COMPANY • 105 MERMAID AVENUE, PHILADELPHIA 18, PA.

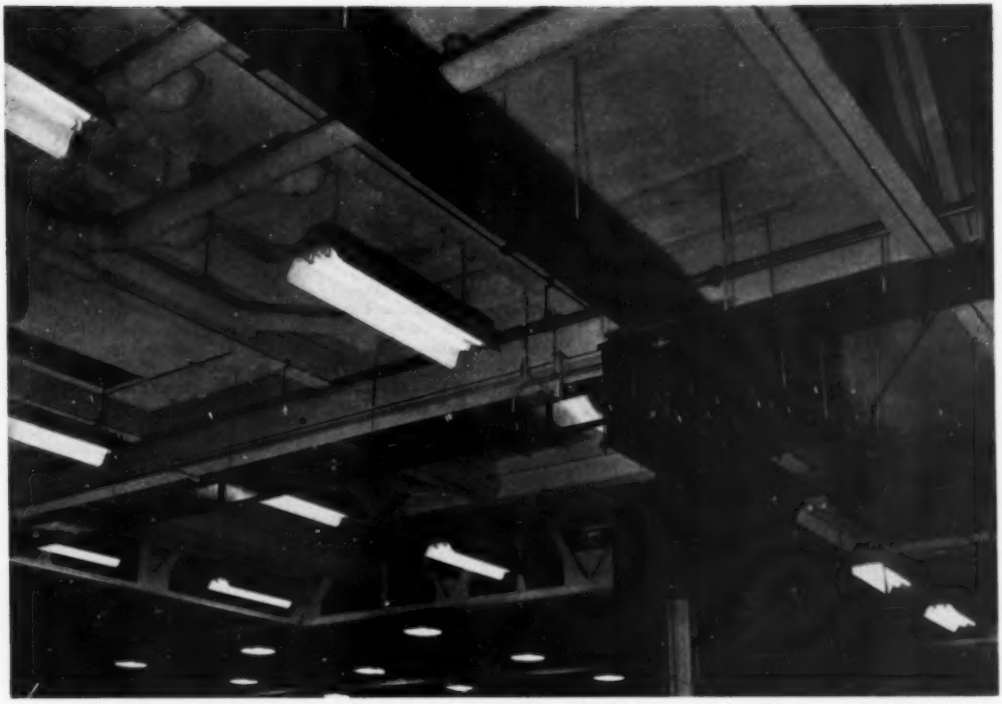


Fig. 1—In a recently completed plant, ventilated low reactance feeder duct carries power from the substation to the smaller production areas. Plug-in duct, branching off through the protective device in cubicle, will accommodate breakers, lighting transformers, trolley duct connections or capacitors to supply individual loads

Selection and Design Factors in BUS DUCT DISTRIBUTION SYSTEMS

For electrical secondary distribution that supplies many small, distributed loads, as well as for other applications, bus duct types have been designed to answer many problems. Here are the advantages along with the factors that should be considered in selecting and designing a well coordinated, efficient and flexible system to meet various applications

H. V. DIAMOND, ***Planning Engineer***
BullDog Electric Products Company

IN SELECTING EQUIPMENT for a secondary electrical distribution system, all factors which will unite to give the safest, most efficient and most flexible system possible without exceeding economic limitations should be considered. Ability of bus duct to meet these specifications in a given application determines the degree of efficiency which can be expected in a secondary network employing this type of equipment.

Construction and Safety

Nominal standards of safety have already been set by the National Electrical Code and by the Underwriters' Laboratory, Inc. However, these are minimum standards and in no way grade the degree of protection provided.

One of the most important additional safety features in bus duct is use of air as the main insulation. The high dielectric value of air is commonly acknowledged, but more important is the fact that it is nearly constant over long periods. Even with the system in use for many years, the insulation be-

tween conductors, and between conductors and grounded parts, does not deteriorate.

Secondary insulators provide both a high dielectric value and mechanical strength. They are used primarily to maintain constant spacing of the bus bars and to prevent their contact with the casing.

The outer casing of metal is formed to provide a rigid support, protecting personnel while also shielding the conductors from mechanical injury. When installed, this rigidity permits the casing to form an integral part of the supporting structure even though the installation is high overhead, where accidental contact is unlikely.

Electrical Efficiency

Design features which are stressed when considering safety are also important when discussing the electrical efficiency of the bus way. Air, the primary insulation, also aids, through convection, in dissipating the heat generated in the current carrying conductors. This, in some instances, allows additional current capacity for certain bus duct designs.

The all metal casing and secondary insulators form a rigid base for the current carrying bus bars. The importance of this feature lies in the well known fact that the impedance of a-c circuits, including skin effect and proximity effect, varies with the distance between conductor centers. Consequently, unless constant spacing is maintained, no accurate rating of voltage drop characteristics can be made.

Ability to accurately foretell the voltage drop at any point on a run is of major importance in the design of the secondary distribution system. This eliminates possibility of excessive voltage drop because calculated values could not be applied to actual operating conditions.

Characteristic Curves

Voltage drop curves published by most bus duct manufacturers will allow calculations to be made for the various types employed in the system. Temperature rise curves, also available, will give the rise above ambient at the hottest point on the duct for different current values. These two curves are of considerable value in the application of bus duct types in the secondary system.

Bus duct is normally applied as a main feeder to a group of small loads because of its large current capacity and convenient outlets. The importance of providing one main feeder can be realized when a diversity factor, for specifying group average effect of intermittent loads, is employed. This effectively means that less conductor material is required in a single common feeder than in a group of feeders, each supplying a small part of the system. Diversity factor is important where the load is primarily made up of motors operating intermittently and at less than full rating.

Flexibility

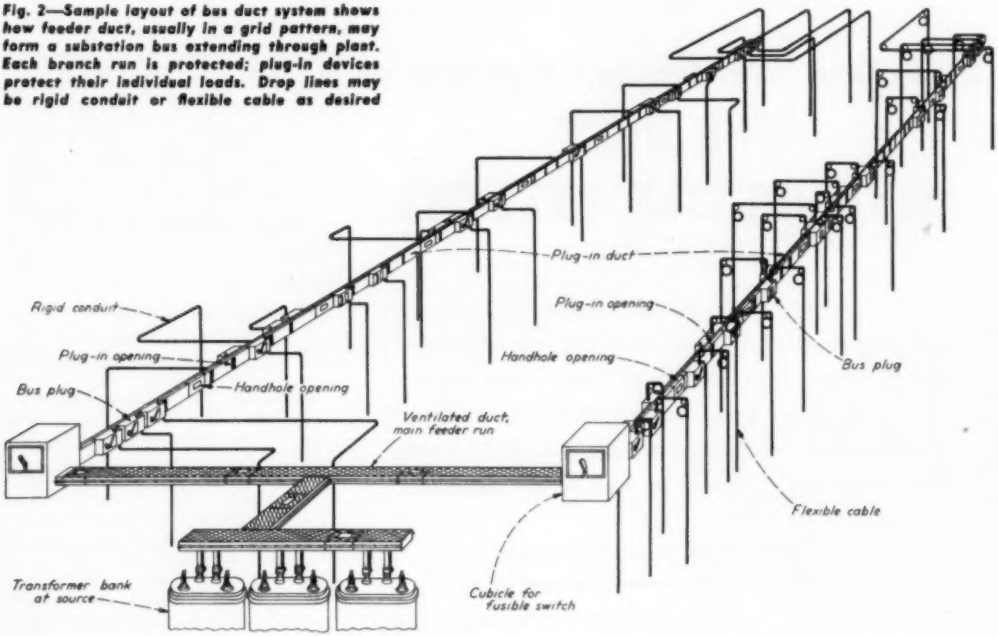
Perhaps the most difficult feature to design into secondary systems is flexibility. It must allow for redistribution of old loads, addition of new loads, and minimize time and cost required for these changes or additions.

Bus duct systems were designed primarily to meet this specific problem and consequently have a built-in flexibility to allow for redistribution or addition of loading. A properly designed system adequately provides for the future as well as present demands, and in addition fully protects the initial investment against undue replacement and maintenance cost.

Of great importance to plant engineers is the salvage value. In the original investment, labor and material are the principal items involved. Labor once used normally has no salvage or reclamation values

The only reclaimable investment is in the material. If properly selected for complete salvability, long life, adaptability, and for frequent moving operations with full reclamation value, it represents a tangible figure. The high salvage value, practically 100 per cent, of bus duct systems, and the small amount of labor in the original installation and in relocation, appreciably reduces total costs. The original investment is always protected.

Fig. 2—Sample layout of bus duct system shows how feeder duct, usually in a grid pattern, may form a substation bus extending through plant. Each branch run is protected; plug-in devices protect their individual loads. Drop lines may be rigid conduit or flexible cable as desired



How Each Type Fits Its Application

Fig. 3 (left)—Low reactance feeder duct, shown here with two conductors per phase, has bus bars disposed for minimum voltage drop. Ventilation increases the current carrying capacity

Fig. 4 (right)—Totally enclosed feeder duct is necessary in some applications. Weatherproof types are available in both ventilated and enclosed casings

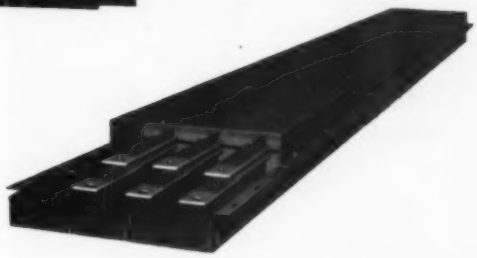


Fig. 5 (below)—Plug-in duct, designed for branch runs, will accept various load connecting devices at frequent intervals. Sections of all types have various fittings and facilities for quick installation and dismantling as needed

Bus duct is designed to deliver power from the secondary terminals of the load center transformer (600 v or less) to the terminals of the utilization equipment. Many applications exist in the secondary network and efficiency of the system depends on selection of the proper type for each particular function.

Application or choice of particular types in the distribution circuit depends, in the extreme cases, upon many factors. However, a clear understanding of the purpose behind design and construction of the various types will solve the majority of the application problems.

In order to provide satisfactory operation, any unnatural ambient conditions or locations or extreme voltage drop limitations must be considered. On the other hand, the load factor, or the ratio of the average to the peak load carried by the duct, is very high. Short time overloads are not harmful because of the slow temperature rise characteristics.

Bus duct is divided into three distinctive types. Each is intended to perform certain functions. Only rarely are they required to overlap and accommodate other functions outside their normal application, a condition brought about mainly by operating requirements of the loads.

The three major classifications are feeder duct, plug-in duct, and trolley duct. When properly combined, they form an efficient distribution system.

FEEDER DUCT

To take advantage of alternating current, it is desirable to run the high voltage lines as close to the load areas as possible and effect the step down to utilization voltage at that point. In most instances, there are still fairly great distances for low voltage circuits when small voltage drops are important.

Where high current values are involved, alternating-current transmission contains certain electrical phenomena, which seriously impairs efficiency of the system. Skin effect, proximity effect, and reactance losses combine to give excessive temperature rise and voltage drop unless the conductor design is used to combat them.

Maximum Ratings

Feeder duct is designed to carry large current values at minimum power loss and low operating temperature. Ampere ratings range up to 4000 amp at 600 v or less. In some feeder designs, it is possible to carry current in excess of 1000 amp per sq in. without exceeding temperature limitations and with little or no increase in power loss.

When discussing bus duct types, nominal or average electrical characteristics should be considered since they vary slightly between different manufacturers. For properly designed feeder duct of the low impedance or low reactance type, the drop will be about 4 v (line to line) per 100 ft when carrying full rated current the entire length of the run. Where a distributed loading of the duct is involved, this value may be reduced by one-half.

Underwriters' Laboratory bases current ratings of all feeder bus ways on a temperature rise standard. Bus duct carrying full rated current continuously must not exceed a temperature rise of 55 C over an ambient of 30 C at the hottest point on the duct. It is interesting to note that wartime temperature limitations were appreciably higher without impairment in operating efficiency. Such high temperatures were considered hazardous to associated electrical equipment, however, and immediately following the wartime period, standard limitations were again imposed.

In order to stay within this temperature limitation and also to provide an increase in electrical performance without the normal increase in conductor size, some styles of feeder duct, Fig. 3, employ a ventilated casing. This allows the air to circulate freely around the current conductors and carries heat generated by the current away from the duct. Feeder duct with a totally enclosed casing, Fig. 4, will normally require larger bus bars for the same current ratings than will ventilated duct because the cooling effect of the air is not present.

Bus bars in all feeder types are supported at certain distances along the casing by high dielectric strength insulators which, in addition to their in-

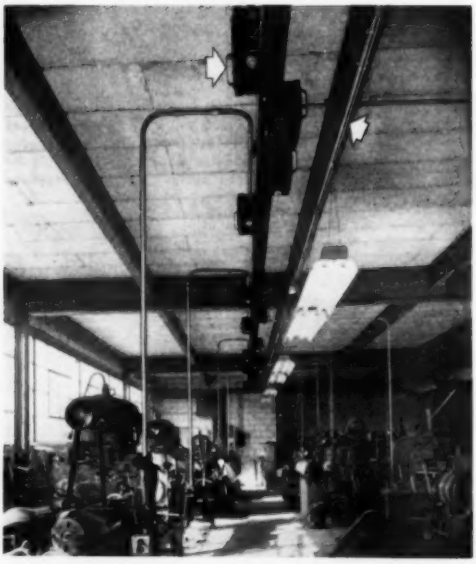


Fig. 6—Installation of plug-in duct illustrates how loads may be connected at convenient points. These plugs are supplied with fuses on outside for machine lighting. The light duty trolley type duct supplies both power and support for the lighting units

sulating qualities, maintain spacing between conductors. Location of insulators is one factor in determining mechanical strength of the duct under short-circuit conditions. The entire rigid construction maintains positive clearances between bus bars and allows accurate electrical characteristics to be evaluated.

The primary application of feeder duct may be made clear at this point. The design allows it to carry large current values at the lowest possible power and voltage loss. Consequently, it is normally applied between the transformers and the switchboard, between the switchboard and the branch plug-in runs, or between the transformer and the branch plug-in runs. In considering the application of feeder duct it may be envisioned as a long switchboard extending through the center of the plant. High current ratings and operating quality takes full capacity of the transformer near any point in the area.

It is important to note that weatherproof feeder duct is the only style of duct approved for use outdoors. Under Article 3642 of the NEC, bus ways are allowed for use in "wet or damp location only when specifically approved for the purpose". Outdoor feeder duct can be obtained in both the totally enclosed or ventilated casing.

Special Loads

Because of the bus bar configuration (designed for low voltage drop, etc.) in feeder duct, access to the power is not as simple as in the plug-in design. Its purpose is to deliver power to main load center areas at lower possible loss; therefore it would normally not be used to feed a number of small loads directly from the duct.

There are cases, however, where the loads are extremely sensitive to voltage variation and it is desirable to feed directly to the utilization machinery. Resistance welders supply the most common example of this type of loading.

Electrical characteristics of feeder duct are admirably suited for use in welder circuits since the large current ratings and low power losses will not affect or be affected by the intermittent operation. Most manufacturers will select the current rating of the duct required for efficient operation for a particular system if presented with information on the welder load.

PLUG-IN DUCT

Plug-in duct, Fig. 5, was also designed to solve specific problems existing in the secondary system. Construction differs from that used in feeder duct in accord with the applications.

Specifically, this style is designed to provide easy access to the bus bars for power taps. With the constant changeover and additions to the system, found in the modern production plant, some easy means of tapping off power from the system should be arranged to minimize lost time in relocation.

Again design designates the application. It can be compared to a panelboard which extends through one section of the load area. Use of the duct however is much more flexible. If a shift in individual loads is required, it is merely necessary to move the circuit protective device (included in the plug-in unit) along with the machine and mount it on the duct at the most convenient location, without interrupting power to other equipment.

To provide access to the current conductors and maintain system flexibility, the conductors are bare bus bars surrounded by a totally enclosed metal casing. The bars are widely separated to permit entrance of the "fingers" of the plug-in units which make contact with the bus bars, and still maintain electrical clearances. This spacing, however, increases reactance drop over that of feeder duct and limits the length of run for a given voltage drop. The main insulation again is air; and secondary insulators support the current conductors and maintain spacing, allowing standard electrical characteristics to be applied.

Access to the bus bars is obtained through openings, Figs. 5 and 6, spaced on both sides of the casing. These are covered when not in use to prevent entrance of foreign material.

A feature sometimes incorporated is polarizing of the plug-in openings. By permitting the entrance of the plug-in units in only one way it is possible to wire them at a bench and insert them in the duct without reversing polarity on the terminals of the electrical load. Some units are also designed to allow the plug to ground against the casing of the duct before contact is made between the plug fingers and the current conductors. This is a safety precaution that, in many instances, is of considerable importance.

In both plug-in duct and feeder duct, conductors are usually silvered at the joints to permit a good contact and reduce the heating at the joint and allow a better electrical connection. Some manufacturers silver the entire surface of the bar on the theory that, if a good contact is required at the joints, it is even more important between the plug-in units and the bus bars.

To permit easy access to the conductors, sacrifices in voltage drop characteristics were necessary. This loss is not important when the duct is properly applied in the system. Nominal value of voltage drop that may be expected in plug-in duct is approximately 6 v per 100 ft when carrying full rated current the entire length of the run. However, the correct application is to carry power to a variety of small, distributed loads, for which the voltage drop may be reduced by one-half, or 3 v per 100 ft. These values are roughly correct for either three phase or single phase systems.

Voltage Balance

Average length of a plug-in run is about 200 ft. Because of the construction of plug-in duct, an unbalance in the voltage drop between phases will usually result when runs over 300 ft are used, and transposition joints are necessary. Two such sections will be used and they will be placed at points one-third and two-thirds of the total ampere feet of the entire run. Where it is difficult to determine the loading on the run, and by assuming the load is evenly distributed, then, as an estimate, sections may be placed at 19 and 41 per cent of the distance of the entire run. Voltage unbalance is not a factor in feeder duct runs, and transposition sections are not required.

Expansion

Difference in the coefficient of expansion between bus bars and metal casing have prompted many engineers to specify expansion joints in bus duct runs. This factor is not of great concern. Electrical performance usually limits the length of duct runs before expansion becomes important. An expansion section should be specified, however, at every point where the duct run crosses a section of the building which contains an expansion joint in the frame. This rule applies to all styles of bus duct.

Protection

Since in most instances, the plug-in duct is utilized as a branch run from the main feeder duct, it is necessary to provide a protective device, Figs. 1 and 2, at junctions. NEC, in Article 3649, specifies that when rating of the bus way is reduced more than two-thirds of the current rating of the protective device next back on the line, or extends more than 50 ft in length, an overcurrent device at that point must be used. This ruling also applies *where the same types of duct* are reduced in size.

Plug-In Devices

Specially designed units used in conjunction with plug-in duct contain a variety of devices. The plug-in units are constructed with switches, circuit breakers, ground indicators, capacitors and transformers. The application of the switches or circuit breakers normally depends on the branch circuit requirements. The capacitor plugs are power factor improvement devices, the transformer plugs are for use with lighting circuits and the ground indicator plug is a safety feature.

TROLLEY DUCT

Portable electric screwdrivers, drills, grinders, traveling cranes, hoists, and other moving motor loads often share substantially in facilitating manufacturing operations. Trolley duct is a flexible electrical system providing a source of power which moves with the job. Electric current is carried in copper bus bars enclosed in an insulated steel casing and transmitted through a trolley to portable tools or other moving electrical devices. A continuous opening is provided on the duct to allow the free movement of the trolley or to permit the insertion of a snap-in connector.

The duct is available in two styles: one a heavy duty duct for use in industrial locations, the other a lighter construction for use primarily in lighting circuits. The electrical characteristic of this type of duct is not of primary importance since it is designed to meet only special applications. The voltage drop, however, will be about 2 v per 100 ft, assuming an evenly distributed load. Operating temperature will not normally exceed 20 C.

As stated above, the duct is primarily employed only where a moving load requires power. Portable electrical tools and hoist and crane applications normally use the heavier duty duct, Fig. 7. The lighter duct, Figs. 6 and 8, is used for lighting distribution and provides continuously available access to the electric conductor, permitting any desired arrangement and rearrangement of lighting fixtures. When changes in lighting are desired, it is only necessary to insert a snap-in connector and attach the lighting unit. The trolley duct also retains the unique salvageable feature of all duct types wherein it can be removed and reinstalled in other locations with a minimum loss in time and material.

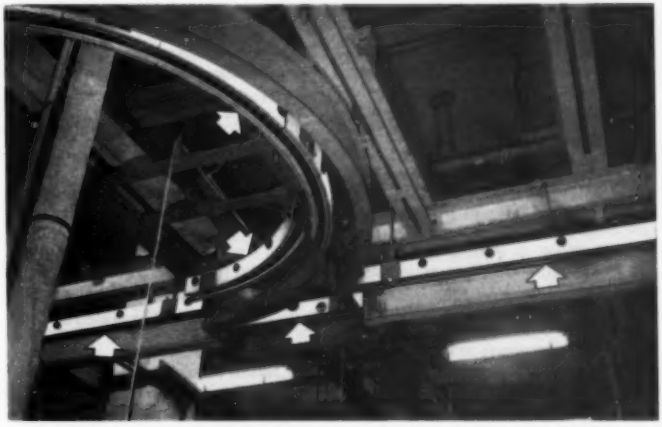


Fig. 7—A normal application for heavy duty trolley duct is as a feeder for a monorail system, providing enclosed circuits and easily erected sections. It also provides mobile support and supply to portable tools

System Design Factors

Protection

An important factor in the proper application of bus duct and one that is definitely related to the efficiency of the system is type of protection used. Despite the fact that the duct is designed for a maximum in safe operation, short circuits and overload conditions may occur, due to the inability of accounting fully for the human factor in the duct operation. These abnormal conditions must be considered although they may never occur.

A proper protective device for a duct run guards it and opens only under current values that may cause damage. It should not open under any other conditions, since this may cause a shutdown of the entire electrical system, which is costly to production.

Normal operating temperature of bus duct as set by Underwriters' Laboratory is 85 C. Time required for the duct to reach a dangerous temperature due to overloading is quite long, and is in excess of that required for operation of the protective device in the overload range. This characteristic makes it mandatory that the protective device selected have a long time delay in the overload range, which will allow the duct to carry short time

Fig. 8—Another example of plug-in and lighting duct installed prior to setting up load requirements. Note that lighting fixtures can also be rearranged or increased to meet changing requirements for area served

overloads without opening and causing a shutdown of the electrical system. However, it will still operate before the overload becomes harmful to the duct.

Short-Circuit Allowances

Extreme care must be taken, however, in the selection of a protective device for operation in the short-circuit range. Standard application rules with reference to short-circuit protection are designed to minimize the damage due to a short circuit. If proper tripping characteristics are selected in the protective device, the duct will be able to carry power immediately after the short has been removed because duration and damage have been limited. The air will have regained its dielectric qualities, and any minor repairs needed can be delayed until a more suitable time.

Experiments conducted on bus duct have shown that no major damage will result if any value of current is cleared from the system within 6 c or 0.1 sec. This 6 c limitation, which applies to *any value of short-circuit current,* is the primary factor in the selection of the protective device.

Arcing faults will usually cause currents lower than those of a bolted short. Greatest danger in arcing faults is not the current that will flow, but the burning effect of the arc. It travels away from the source of the power and as it travels it burns the surface of the bus bar. This pitting will materially affect the contact that the plug-in units will make with the conductor bars.

If an arcing fault occurs at the end of a long run of duct, the current value drawn may not be large enough to cause fast operation of the protective device. Considerable damage to the duct may occur in this period. By calculation, it has been found that the minimum value of short-circuit current that will occur on a bus duct run will fall between six and ten times the current rating of the duct. Consequently, as a standard rule, the protective device must operate and open within 6 c at five times the duct rating. This calls for a special setting on the instantaneous trip coil of circuit breakers, if they are employed. When fuses are used, a study of the interrupting curve must be made to see that the device fulfills this five-time rule.

There are certain circuits where an exception can be found. Bus duct runs used to feed several large motors, or runs which are feeding welders, will be excluded. The setting is too low and may cause unnecessary shutdowns for current values that are not harmful to the duct. A standard tripping time may be utilized in these instances. However, it is suggested that duct runs be made as short as possible in order that the smallest short-circuit values will cause operation of the protective device.

Short-Circuit Strength

Considerable importance has recently been placed on the ability of bus duct to withstand high short-circuit currents. Under short-circuit conditions, the magnetic fields surrounding the bus bars are increased many times and the force tends to bend the bus bars and damage the duct.

There is, at this time, no standard testing procedure for rating short-circuit strength of bus ways. Any rating of this type is based upon the bus duct manufacturers' interpretation of what constitutes "withstanding" short-circuit currents. In most instances, it is interpreted as the value of short-circuit current the duct can carry without failure mechanically and with no appreciable change in its electrical characteristics.

The rating assigned the duct is normally based on size of bus bars employed, pacing of insulators, clearances existing between opposite polarity conductors and the metal casing.

In general, the short-circuit rating of the duct will increase as the continuous current rating of the duct becomes larger. Manufacturers should be consulted regarding the short-circuit ratings to obtain a clear understanding of the basis for assigning these values.

Installation Factors

Bus duct may be installed horizontally or vertically, mounted on the wall or ceiling, suspended from structural steel or messenger cable. It is readily interconnected by fittings, such as elbows, tees, and crosses to fit any building layout.

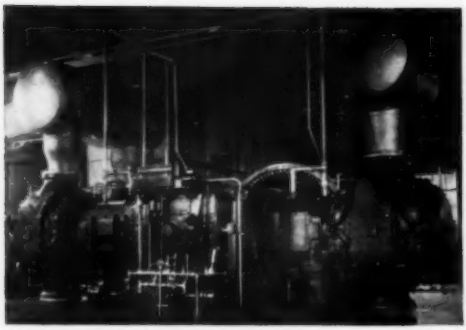
The NEC demands that the duct be supported at 5 ft intervals unless specifically approved for support at greater spacing, but in no instance should this spacing exceed 10 ft. The duct must be totally enclosed or shielded for a height of 6 ft when extending vertically through floors to protect against mechanical injury. When installed in the vertical position, care must be taken to provide adequate support.

Typical Installation

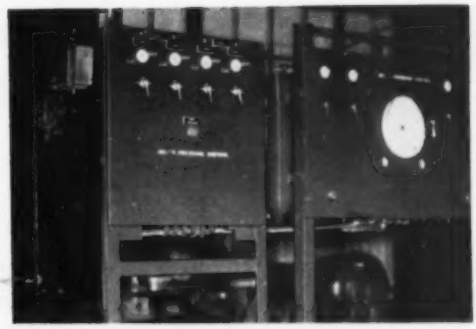
The general design of a bus duct system tends to form a grid pattern covering the entire load area of the plant. Main feeder duct runs and branch plug-in duct runs interconnect through protective devices to provide convenient power outlets at any point in the loading area. Where trolley duct runs occur, power may be supplied from plugs attached to the duct.

Where two or more substations provide power for electrical loads, a full grid system can be designed to cover the entire load area and yet have a flexibility that will prevent the overloading of any one substation. Duct systems from each substation are mechanically interconnected but electrically sectionalized. As the load shifts and danger of overloading in one substation appears, the sectionalizing points on the duct network are shifted to again evenly distribute the load from each power source.

Additional substations can be attached to the system and the duct network resectionalized to evenly distribute the loading.



Horizontal-opposed cylinder air compressor is provided with surge tanks at the suction and discharge sides



Uniform air delivery is maintained by means of pneumatically operated unloading valves on discharge cylinders

PROCESS AIR AT PFIZER COMES OUT CLEAN

Dry, clean, compressed air, one of the ingredients necessary to produce antibiotics, is available 24 hr a day, 7 days a week. Intake air is filtered in an oil bath filter and moisture is removed following final compression in outdoor aftercoolers

THE CHAS. PFIZER & CO., INC., Vigo plant in Terre Haute, Ind. is but one of three plants operated by this company for producing antibiotics. At Terre Haute, it processes only the three basic elements for terramycin and streptomycin that are subsequently refined and packaged at the main plant in Brooklyn, N.Y.

Fine points in manufacturing antibiotics are naturally top drawer secrets known only to a few pioneers familiar with the research involved. Little has been made public as to the type of equipment employed in the process. However, one prime element vital for production of cultures is air. What is done with the air inside the closely guarded plant remains top secret, but how the air is processed for delivery to the production lines can be told. If the precise care and control of the air is any criteria for what goes on inside, then the techniques for developing antibiotics are indeed mass precision operations in every sense of the word.

Operational success depends on clean air for processing, and all foreign matter that might contaminate reactions and possibly destroy substantial quantities of materials in process must be removed. A second requirement of absolute importance is that the air supply be dependable on a 24-hour-a-day schedule since the processing is continuous. Failure of air supply would obviously be disastrous.

Outside air is drawn through a filter that has a continuous moving chain passing through an oil bath to automatically clean out all impurities. Filtered air is directed to a surge tank mounted directly above the first stage section flanges of a two-stage horizontally-opposed 3 cylinder air compressor. This tank eliminates pulsations and delivers a uniform supply of clean air to the first stage cylinders. The technique assures more efficient compressing of air than would be otherwise possible.

The Cover --- Air for Antibiotics

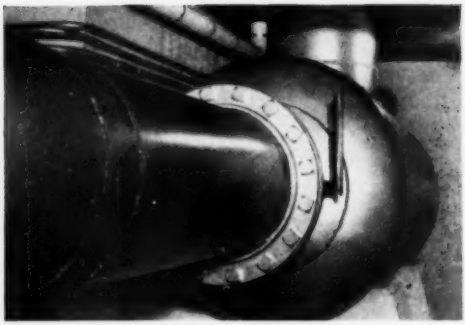
Acknowledgment is made to the Cooper-Bessemer Corp. not only for this month's cover, but also for illustrations contained in article starting on this page. Air, an important item in antibiotics, is delivered by C-B compressors.

Antibiotics, wonder drugs of modern medicine, are writing new and glorious chapters into world history. Penicillin with its newest first cousins, terramycin and streptomycin, along with undiscovered others yet to come, are today turning back diseases with miracle-like success in cases not too long ago considered hopeless or requiring long periods of treatment and convalescence. With its ever accelerating progress in research into this comparatively new field, medical science soon hopes to have a relatively complete family of "miracle" drugs that will be effective in winning mankind's constant battle against ailments.

Critical urgency for vast quantities of these drugs is obviously taxing the finest creative abilities of leading research minds to further perfect the wonder compounds. In the fervent race against time, test tube processes one day are often pilot production runs within 24 hr. Complex problems of controlling reactions in test tubes obviously are multiplied thousandfold when setting up processes in large scale production. Unknown complications in development of cultures that produce antibiotics are of course giving chemists no end of difficulty in spite of expert eyes and constant process improvement.

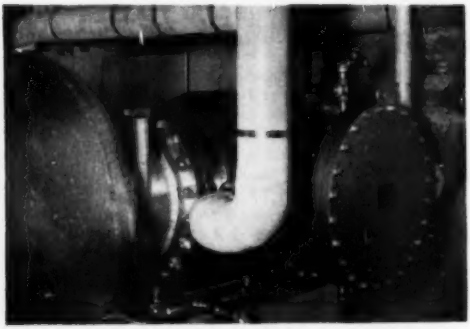
While precious progress has been made in many phases, much of the whole story of antibiotics is yet to be explored. The surface of unlimited possibilities that biochemists see ahead has only been scratched. Perhaps the ultimate may see reliable remedies for presently incurable ailments in man as well as in animals on which man is dependent for food.

Today, by-products from the production of terramycin are gaining widespread attention by the agricultural department. One, presently known as "TM-5", is being widely used in feedstuffs to accelerate animal growth.

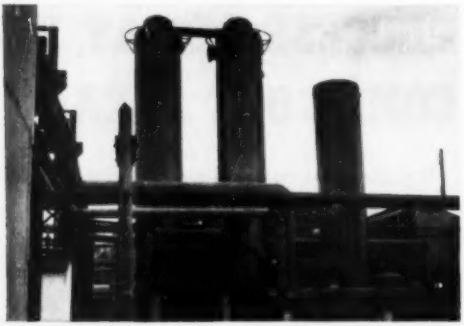


Surge drum, fabricated from pipe and fittings is at sub-floor level between the high and low pressure cylinders

Outside air is drawn through this oil bath filter and cleaned before it enters the low side of the compressor



Hot compressed air from the first stage of compression is cooled in an intercooler before entering second stage



Aftercoolers, located out of doors, condense and remove water vapor and entrained oil from the high pressure air

Discharge from the low pressure cylinders is through an intercooler, which reduces the air temperature and volume and assures more efficient compressor operation in the second stage. At the same time, moisture, condensed by the intercooler, is removed.

Entering a second surge tank, the air is compressed to its final discharge pressure. Uniform discharge pressures are attained with unloading valves on both low and high pressure cylinders. These valves are opened and closed pneumatically by a controller that maintains discharge pressures to within 3 per cent. The pneumatic control incorporated on all unloading valves offers exceptionally quiet compressor operation and helps attain a greater ultimate in continuous performance so vital on this type of antibiotic work.

Compressed air from the horizontal-opposed cylinder unit is piped to aftercoolers located out-of-doors. Here the final condensation process takes place, and essentially all water vapor and oil mist are removed from the air. The air, thus clean and dry, is ready for delivery to various plant operations.

Using an opposed-cylinder horizontal-type air compressor has enabled Pfizer engineers to utilize several desirable benefits on this kind of operation. In addition to the smaller foundation required, considerably less head room was actually needed to accommodate the horizontal-type compressor and surge tanks. The resulting simpler and more compact installation has also meant remarkable freedom from vibration due particularly to the horizontal-opposed cylinder construction.

The air compressor is equipped with independent electric motor-driven lubrication pumps that supply oil under full pressure to all bearing surfaces prior to starting. This foresight eliminates possible breakdowns from lack of lubrication at start-up.

By powering the compressor with a 1250 hp synchronous motor, the plant engineers at Pfizer's Terre Haute plant are able to attain a favorable power factor close to unity. This enables the purchase of electric power at lower rates by eliminating the waste or wattless current so common with many industrial users. Electric power is purchased from local utilities and handled through switchgear at 2300 v.

PRINCIPAL AIR HANDLING EQUIPMENT

Compressors	The Cooper-Bessemer Corp.	Switchgear	General Electric Co.
Air filters	American Air Filter Co. Inc.	Intercoolers	Ross Heater & Mfg. Co. Inc.
Pressure controllers	Taylor Instrument Companies	Oil separators	Wright-Austin Co.

COMBUSTION AND COMBUSTION GUIDES

Efficient fuel utilization requires accurate control of the air supply. Many plants employ combustion guides to furnish intermittent or continuous data on this important detail and insure economical operation of their boilers

ORVAL W. RIGGS
Manager, Application Engineering
The Hays Corporation

COMBUSTION is a complex subject about which many complete books have been written. The term combustion guides takes in many types of instruments and applications. Consequently, any condensed treatment of these two subjects must touch on only some of the fundamental factors involved and the general trends.

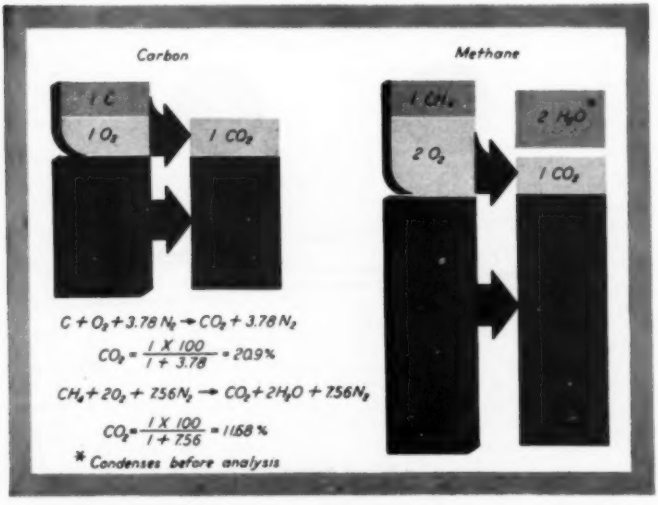
Basically, good combustion involves the proper combination of fuel and air, temperature, turbulence and time. In most fuels, the principal elements will be carbon and hydrogen, although some will contain small amounts of sulfur, while others, such as blast furnace and producer gas, will include relatively high percentages of CO. This article devotes attention primarily to the oxidation of hydrogen and carbon.

Essentials of Good Combustion

In the burning of any fuel, the main objective is to utilize all available combustible without losing valuable Btu up the stack or in the ash pit. Enough oxygen must be supplied to consume all of the fuel. However, any excess oxygen and nitrogen that appears in the combustion gases must be heated, and since heat contained in gases leaving the boiler is lost, air supply should be held to a practical minimum. Furthermore, increasing the volume of gases also increases the velocity with which they pass through the furnace and boiler. As heat transfer depends partially on the length of time that gases are in contact with heat absorbing surfaces, increased velocity reduces heat transfer and causes higher gas temperatures.

There is considerable difference between practical and theoretical fuel - air ratios, and actual requirements will depend on the fuel, the furnace shape and size, the ash softening temperature, the method of ash disposal and other factors of boiler and fuel burning equipment design. In some cases, where coal and gas are burned in the same furnace, it may even be necessary to consider superheat temperature in arriving at the proper fuel - air ratio. Some excess air will always be required, and after the practical ratio for best over-all performance has been determined, considering combustion efficiency, maintenance and steam production, efforts can be directed towards maintaining proper conditions.

Fig. 1


Carbon
1 C
1 O_2
1 CO_2
$C + O_2 + 3.78\,N_2 \rightarrow CO_2 + 3.78\,N_2$
$CO_2 = \frac{1 \times 100}{1 + 3.78} = 20.9\%$
Methane
1 CH_4
2 O_2
2 H_2O*
1 CO_2
$CH_4 + 2O_2 + 7.56N_2 \rightarrow CO_2 + 2H_2O + 7.56N_2$
$CO_2 = \frac{1 \times 100}{1 + 7.56} = 11.68\%$
* Condenses before analysis

Theoretical Air Requirements

As previously mentioned, carbon is one of the two main elements in fuels. When burning pure carbon, one molecule of carbon combines with one molecule of oxygen to produce one molecule of CO_2. Since air consists of 20.9 per cent oxygen and 79.1 per cent nitrogen by volume, each molecule of oxygen is accompanied by 3.78 molecules of nitrogen, which carries through the boiler without any change. Therefore, the combustion gases contain one molecule of CO_2 and 3.78 molecules of nitrogen, which means CO_2 constitutes 20.9 per cent of the total volume. This, of course, corresponds to the percentage of oxygen in air and is correct as all oxygen in the air has combined with carbon. Adding carbon to oxygen does not change the volume of the gas but does change its weight. A molecule of CO_2 has the same volume as a molecule of oxygen but is heavier.

Carbon is at one end of the fuel scale with various forms of coke and anthracite coal approaching this limit although all contain some hydrogen. At the other end of the range normally encountered in industry is methane or CH_4, one of the main constituents of natural gas. Burning methane involves combining the carbon with oxygen to form CO_2 and the hydrogen with oxygen to form water. One molecule of methane, two molecules of oxygen and 7.56 mole-

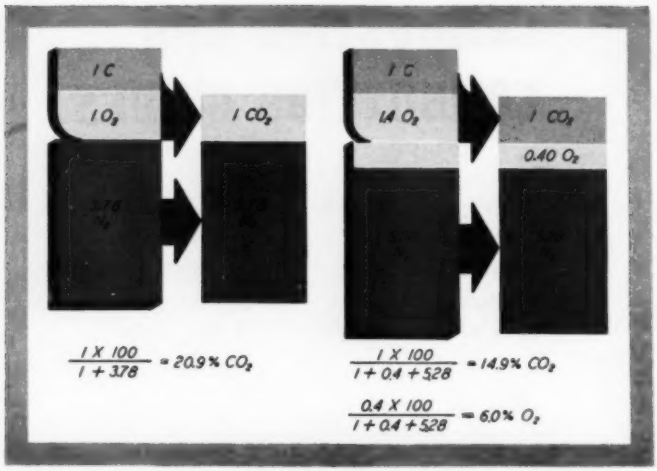


Fig. 2

cules of nitrogen produce one molecule of CO_2, two molecules of water and 7.56 molecules of nitrogen. In order to reduce gas measurement to some standard base, it is common practice to consider all flue gas analyses on a dry basis and all water vapor is removed or cancelled out. Consequently, when burning Methane CO_2 will be 11.68 per cent of the total volume of combustion gases with water removed. The equations representing these two extreme theoretical conditions are shown in Fig. 1. Most common fuels should fall within these two limits, and the percentage of CO_2 between 11.68 and 20.9 will depend on the hydrogen - carbon ratio.

The term hydrogen - carbon ratio is used to indicate the relationship between the hydrogen and carbon content of the fuel. It represents the ratio of hydrogen by weight to carbon by weight. Consequently, the hydrogen - carbon ratio for pure carbon is zero and that of methane is 0.333.

Excess Air

In Fig. 2, the values shown on the left are the purely theoretical calculations previously mentioned and do not take into account the fact that excess oxygen or excess air will be required to insure complete combustion. If 40 per cent excess oxygen or air was used during the burning of carbon, the oxygen and nitrogen percentages would be increased by 40 per cent. Since only the same amount of oxygen is utilized for burning the fuel, 0.4 of a molecule of oxygen and approximately 5.28 molecules of nitrogen would appear in the combustion gases. Under these conditions, CO_2 content will be reduced to 14.9 per cent but a new element, excess oxygen as approximately 6.0 per cent O_2 will also appear in the gases.

If there is a deficiency of oxygen, all of the carbon does not oxidize to CO_2 and some CO occurs in the exit gases. Presence of any CO represents a real loss as one lb of carbon burning to CO yields only 4350 Btu whereas one lb of carbon burning to CO_2 yields 14,550 Btu. Thus the second atom of oxygen produces a much greater heat release than the first, and insufficient oxygen causes a substantial heat loss.

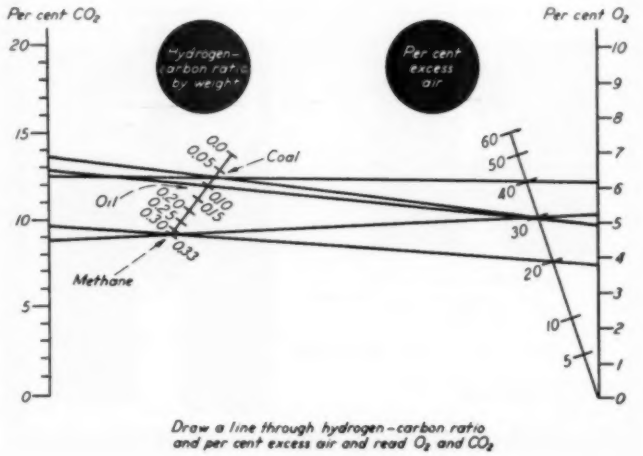
Fig. 3 shows the relationship between oxygen, excess air, CO_2 and hydrogen - carbon ratio for various fuels. The short diagonal line in the left center, calibrated from zero to 0.33, is marked in terms of hydrogen - carbon ratio. As previously mentioned, carbon has a zero ratio and methane a ratio of 0.333 with most of the other conventional fuels falling between these two points. Some bituminous coals will fall at about 0.07 on the scale, while some fuel oils will have an approximate 0.11 hydrogen - carbon ratio. If hydrogen and carbon are essentially the only two combustibles present and the hydrogen - carbon ratio of the fuel is known, the percentage of CO_2 and O_2 can be determined for any percentage of excess air. For a fuel having a hydrogen - carbon ratio of approximately 0.07 with 40 per cent excess air, drawing a line through the proper points on the respective scales gives 12.7 per cent CO_2 and 6.2 per cent O_2. It would, of course, also be possible to determine the approximate hydrogen - carbon ratio of a fuel and the percentage of excess air if the percentage of CO_2 and O_2 were known and no combustibles were present.

Although CO_2 percentage will vary widely, O_2 percentage will remain very nearly the same for any given amount of excess air regardless of the variation in hydrogen - carbon ratio. For example, with 30 per cent excess air, the oxygen content is approximately 5 for bituminous coal and 5.25 for methane while CO_2 content varies from 8.8 to 13.7. This relationship is significant when several fuels of different hydrogen - carbon ratio are burned.

Orsats

In establishing the fuel - air ratio to be maintained, measurements of oxygen, CO_2 and CO are desirable to determine the amount of excess air and to prove that combustible in the form of CO is not being lost. Fig. 4 shows the conventional three chamber hand orsat normally employed to test gas samples. This instrument has three pipettes or chemical chambers, in which CO_2, O_2

Fig. 3

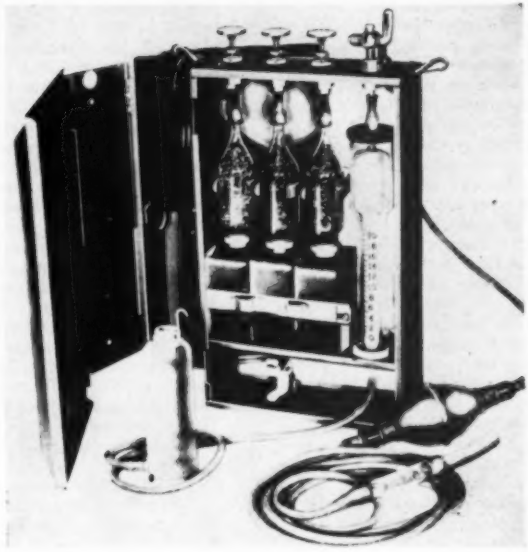


and CO are absorbed and the resulting change in volume measured. From this information, both operating procedure and fuel - air ratio can be established. Orsats also provide a means of checking other combustion guides in the plant and furnish data necessary for calibrating instruments such as the air flow - steam flow meter.

Types of Combustion Guides

In addition to this test instrument, most plants use an instrument to provide a continuous record of combustion efficiency. Such an instrument is valuable not only because of the record itself but also because it shows both the direction and rate at which any change is occurring and enables the operator to make adjustments of the proper magnitude. There are two general types of recording combustion guides available, qualitative and quantitative. Flue gas analyzers such as CO_2 and O_2 recorders are of the qualitative type as they actually measure percentages of gases present rather than quantities. Air flow - steam flow or gas flow - air flow meters are of the quantitative type since they measure the total flows involved. Each type of instrument has a definite place in the combustion picture.

Fig. 4



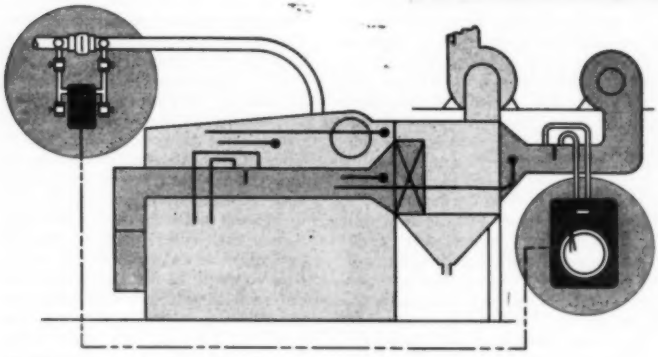


Fig. 5

Air Flow — Steam Flow Meters

Air flow - steam flow meters assume that a fixed amount of air is required to produce a pound of steam at a given pressure and temperature. If steam at 600 psig pressure and 600 F temperature containing 1287 Btu per lb is generated from feedwater at approximately 300 F having 268 Btu per lb, the difference of 1019 Btu per lb between the total heats must be supplied by the boiler. Since this total heat must come from the fuel, the relationship between heat absorbed in the boiler and heat released by the fuel must be considered. Therefore, assuming an efficiency of 75 per cent, a total heat of 1358 Btu must be supplied by the fuel for each pound of steam produced. If the fuel is a typical bituminous coal, Fig. 9 shows 7.7 lb of air are needed to produce 10,000 Btu, which is equivalent to approximately 1.04 lb for 1358 Btu. Adding 40 per cent excess air to this theoretical value establishes the actual requirement of 1.46 lb of air for each pound of steam generated. Then assuming this relationship applies for the full range of operation, the steam flow - air flow meter can be calibrated so that the pens are together on the chart when 1.46 lb of air are flowing for each pound of steam. By keeping the two pens together at all ratings, the proper fuel - air ratio can be maintained. Actual calibration of this instrument would be accomplished through flue gas analysis as in most cases it would be impractical to actually calculate the air flow and design an exact metering arrangement.

Although this relationship is based on a number of assumptions, it will be accurate enough to serve as a reliable guide for many installations. It is true that anything affecting boiler efficiency or heat transfer within the boiler will introduce some error, and wide variations in steam temperature and pressure or feedwater flow could be troublesome. Air temperature should be reasonably constant, and fuel type or quality should not vary enough to seriously affect the relationship between Btu release and air requirements.

In addition to the theoretical considerations, there are some practical problems connected with the application of air flow - steam flow meters. It is generally assumed that steam flow can be measured accurately down to 20 per cent and with some degree of accuracy down to 10 per cent. Air flow must be measured with corresponding accuracy if the relationship is to mean anything. Consequently, the method of measuring air flow and the range of operation should be considered. Since air pressure will vary as the square of the flow, it is important that the differential at maximum rating is high enough to insure accurate readings at minimum rating.

Measuring Air Flow

Fig. 5 shows several of the many methods for measuring air flow. The preferred method is to measure the differential across an orifice plate installed in the forced draft duct as air at this point is cool and clean which

eliminates troubles resulting from dirt and varying temperatures. As only air actually being supplied to the fuel burning equipment is measured, infiltration that might occur in and beyond the furnace is not included. Of course, care must be taken to assure that the air is actually combining with the fuel and not passing around the end of the grate or through some point where it does not enter into combustion.

The air side of the preheater also provides a convenient place for measuring air flow if there is no bypass. For applications where air must be bypassed at light loads, the preheater is not suitable for air flow measurement. Draft loss through the boiler is quite commonly used and is satisfactory on many jobs. However, dirty gas is being measured, and the condition of the boiler will influence the air flow reading. One of the biggest problems is the fact that draft loss is rather low on many boilers, and the small differential makes it difficult to obtain accurate readings.

On some natural draft, oil or gas fired boilers using only one burner, differential can be measured between the last pass and atmosphere using the burner itself as part of the orifice. This arrangement will not work if there is more than one burner per boiler as varying the number of burners in service changes the size of the air orifice, thereby upsetting air flow - steam flow relationship. Generally speaking, the quantitative meter does a satisfactory job providing air flow can be measured satisfactorily and operating conditions and fuel characteristics do not vary too widely.

CO2 Recorders

Combustion guides of the qualitative type or gas analyzers actually measure the percentages of certain components in the exit gases and provide a direct check on efficiency. Their accuracy is not affected by variations in steam pressure or temperature, feedwater temperature or regulation, air temperature or the condition of boiler heat absorbing surfaces. There are three common methods of measuring carbon dioxide, the CO_2 recorder being the least expensive and most commonly used instrument of this type. One of these methods employs chemical absorption similar to the hand orsat, another compares thermal conductivity of the gases with that of air, and a third measures specific gravity.

Thermal conductivity type CO_2 recorders operate on the principle that every gas has a somewhat different rate of heat transfer. Fig. 6 shows the effect of passing several different gas samples through a thermal conductivity type of instrument that produces a deflection of 100 for a 100 per cent CO_2 sample. The vertical scale shows relative deflection obtained with various gas samples, while the horizontal scale gives the percentage of each gas contained in nitrogen. Nitrogen was used as the base or zero reference line but air would be practically the same. Generally speaking, in combustion gases CO_2, nitrogen and some oxygen would be the principal gases present. Small quantities of other gases such as argon and even small percentages of SO_2 would have little effect on the reading since they produce a deflection in the same direction as CO_2 but of slightly different magnitude. Sizable quantities would introduce an error but the amounts normally encountered could be calibrated out since there will be a definite relationship between their percentages throughout the range of the instrument.

Hydrogen will produce a substantial error in the reading because it has a very pronounced deflection in the opposite direction from that of CO_2. In some cases this may prove to be advantageous as hydrogen may begin to show up when a deficiency of air exists, and even a small amount will reduce the CO_2 reading. A sharp drop in the record when operating at high CO_2 values would indicate the presence of hydrogen.

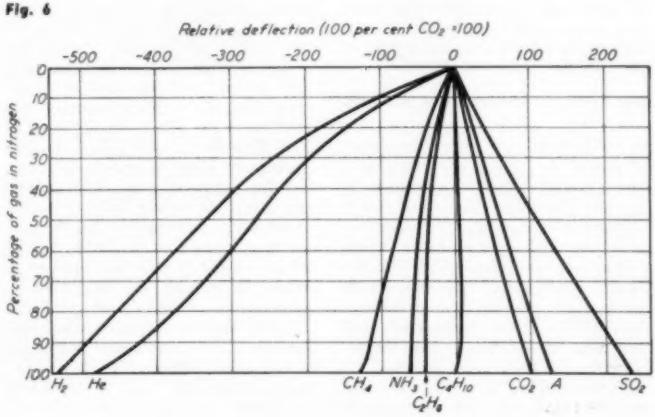
Fig. 7 shows the cell block assembly used in one thermal conductivity CO_2 recorder. There are two identical cells each containing a heated resistor forming part of a resistance bridge circuit. The measuring cell receives gas samples while the isolated comparison cell contains air, both being saturated to provide an analysis on a standard basis. The heated resistors are small in diameter and have very little mass so there is very little heat inertia present and temperature changes are rapid. As the gases conduct heat away from the heated resistor in the left hand cell, the temperature decreases, the amount of change being dependent on the thermal conductivity of the gas in the cell. Meanwhile, air occupies the right hand cell at all times and keeps the resistor on this side at a fixed temperature and, therefore, a fixed resistance. Since these two heated resistors form legs of a resistance bridge, the difference between the two elements can be determined thereby showing the thermal conductivity of the gas in the cell.

Multiple Fuel Firing

Refineries, steel mills and other industries have for many years burned a combination of fuels consisting largely of by-products from various processes. In recent years, the trend toward burning several fuels instead of a single fuel has spread to all industries. Special rates on gas at specified times, lack of coal at other times, and the desirability of burning liquid or gaseous fuels under certain load or process conditions have all influenced this change. Therefore, when considering combustion problems, some thought will have to be given to multiple fuel firing.

Fig. 8 illustrates in another form the relationship between O_2, CO_2 and excess air for various fuels previously discussed in connection with Fig. 3. These charts show that for a given percentage of O_2 there is very little difference in excess air percentage even though the fuel is changed from coal to natural gas. When burning gas, the percentage of excess air would be less than it would be for coal, but limits can easily be established for maintaining the oxygen reading at the desired point for the particular fuel being burned. Actually, a chart calibrated in per cent excess air can be prepared so that the instrument will provide direct readings for any type of fuel.

Fig. 6



The pounds of air required to liberate 10,000 Btu with various types of fuels are shown on the vertical scale of Fig. 9. The horizontal scale is not calibrated as there is no direct relationship between air requirement and hydrogen content. In general, however, as the hydrogen content of the fuel increases the amount of air required for 10,000 Btu is reduced. These values are all theoretical and do not consider the question of excess air. Actually, the difference in the amount of air required by coke and coke oven gas is more than that shown on this chart while greater percentages of excess air would be needed with any of the solid fuels than with gas or oil. Consequently, no fixed relationship between air flow and heat produced can be assumed for all types of fuels.

Since the air flow - steam flow meter operates on this principle, either the instrument would have to be recalibrated for various conditions of firing or some factor would have to be applied. In some plants, the operators are instructed to keep the pens a fixed distance apart when using an instrument calibrated for coal firing on gas firing. This, of course, changes the relationship between fuel and air and may be correct at any given point. However, a percentage change is actually required, and if a constant difference is maintained between the two pen positions the ratio will not be correct over the full range of operation. Since oxygen percentage remains nearly constant for a given percentage of excess air with wide variations in fuel composition, the oxygen recorder gives a direct check on combustion conditions independent of hydrogen - carbon ratio and relationship of air flow and heat release.

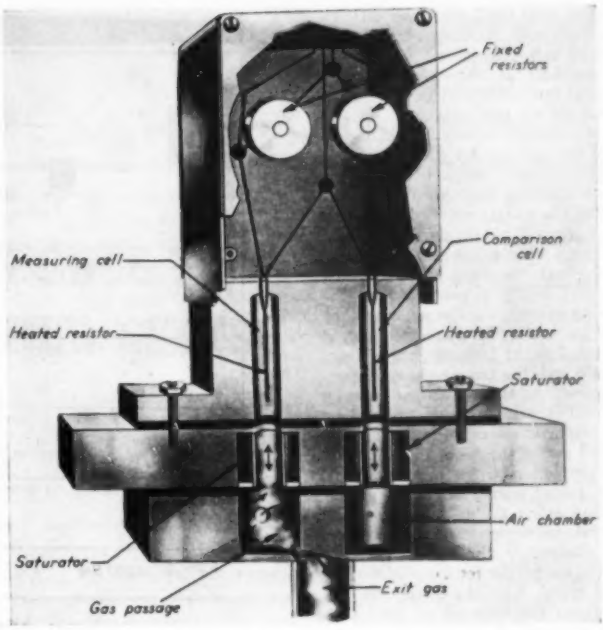


Fig. 7

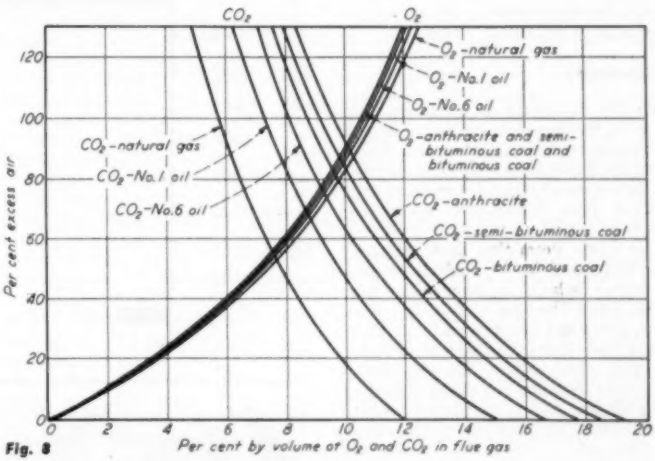


Fig. 8

O2 Recorders

A number of good oxygen recorders have been developed within the past few years. Some of these instruments measure the heat developed by combining the oxygen in a gas sample with standard fuel while some compare changes in thermal conductivity resulting from this procedure. Others use the paramagnetic properties of oxygen as a basis for measurement.

Oxygen is one of the few gases that can actually be attracted by a magnet, and although this effect is small when compared with the attraction of iron, it can be measured. Compared to other gases normally encountered in combustion processes, the effect of a magnet on a stream of oxygen is easily detected. Fig. 10 shows the deflection secured by passing various gas samples through equipment calibrated to produce 100 per cent deflection for a sample containing O_2. Pure samples of other common gases show only small deflections, and because most of them are slightly diamagnetic, they produce negative effects. The only gases producing substantial readings are NO and NO_2, neither of which is encountered in combustion work. Since there is little interference from other gases, this system can be used for O_2 measurement even though the magnet does not separate the oxygen but attracts the entire gas sample. However, if the attraction can be measured, the percentage of oxygen in the gas stream can be determined.

Two views of the cell block arrangement in one oxygen recorder are shown in Fig. 11. This cell assembly has two identical compartments, each containing a filament or precision wound spiral with very little mass and therefore, very sensitive to any cooling effect. These two spirals form the legs of a bridge circuit which measures the difference in resistance between the two spirals. Gas enters through an

opening near the bottom and diffuses into both cells, conditions being identical on each side when the magnet is thrown back as shown at the left. Normal convection currents have equal effect on the two cells and do not cause unbalance in the electrical bridge.

In the right hand view a permanent magnet is placed around the left cell to create a strong magnetic field at the end of the spiral, while conditions in the right cell remain unchanged. Gas diffusing into the left cell is drawn into the magnetic field, the rate of attraction being dependent on the amount of oxygen in the stream. When this gas enters the magnetic field, it is heated by the filament in the bridge circuit and the oxygen becomes less magnetic. As the cooler gas entering the cell is more strongly attracted by the magnetic forces, the heated gas is forced out of the field, thereby creating circulation in the measuring cell. This forced circulation has a greater cooling effect on its spiral than the normal convection currents have on the filament in the right hand cell, which changes the resistance of the left hand spiral. Since the differential depends on the velocity of the gases passing the spiral and the effect of the magnet on the gas stream, O_2 content can be determined by measuring the change in resistance.

Summary

The percentage of excess air, CO_2 or O_2 that is correct for any plant will have to be determined through the experience and knowledge of the operating personnel. Once proper conditions have been determined, combustion guides including the hand orsat, the air flow - steam flow meter, the CO_2 recorder and the O_2 analyzer, are extremely helpful in maintaining high efficiency. The hand orsat is the test instrument and can be used for calibrating other instruments such as air flow - steam flow meters. The air flow - steam flow meter is a simple recording guide that does an excellent job where pressure, temperature, boiler conditions and fuel composition do not vary too widely, and where air flow can be measured. CO_2 recorders offer a continuous record and provide a direct check independent of all variables except hydrogen - carbon ratio. The oxygen recorder is a universal guide providing accurate information independent of all of the variables except excess air percentage and that can be read directly from the instrument. Each instrument has definite value and only experience and knowledge of operating conditions in the plant will permit precise determination of the one to use for a particular application.

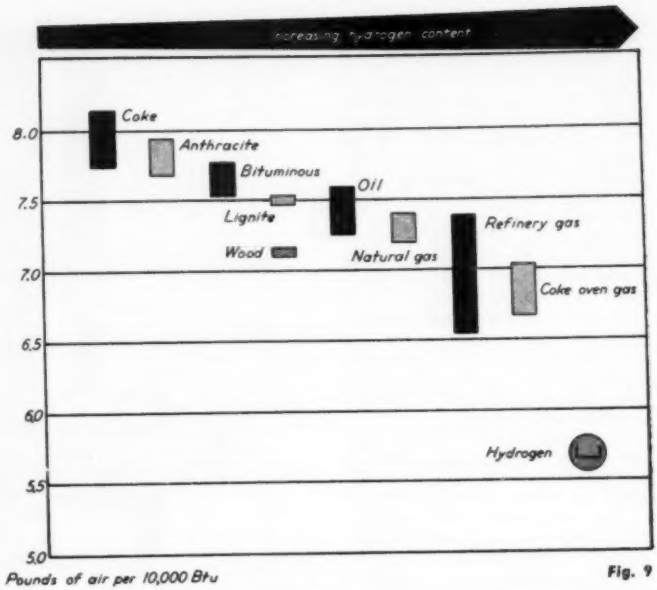


Fig. 9

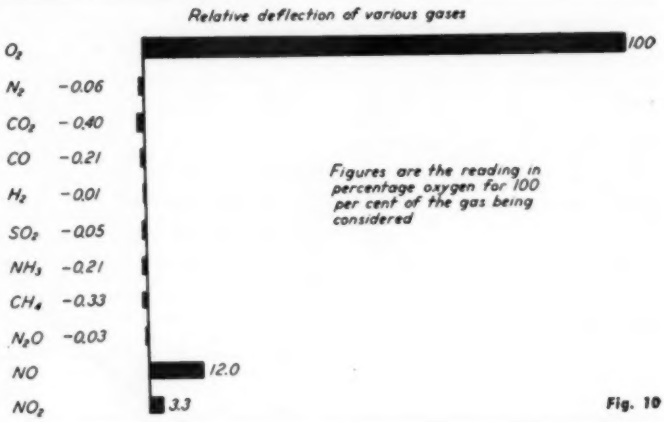


Fig. 10

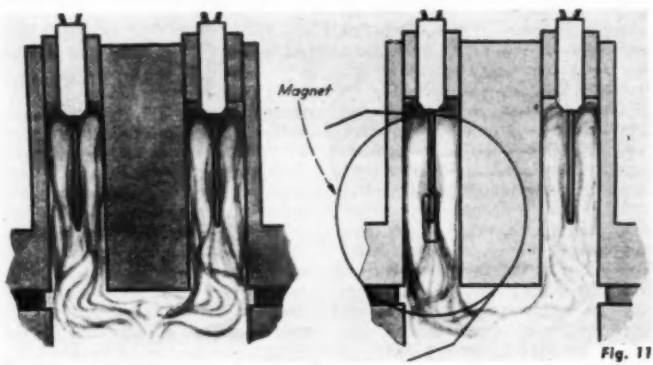


Fig. 11

Power transmission

Engineering data and information to aid in selection, application and operation of equipment used in transmission of mechanical power

SPECIAL TECHNIQUES FOR ENDLESS LEATHER BELTS

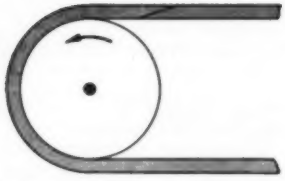
This article gives detailed information on how to make leather belting endless—whether the belt is installed in place or prefabricated. Studying these simple, but excellent, steps will assure efficient leather belt service

TABLE 1—SINGLE BELT LAPS

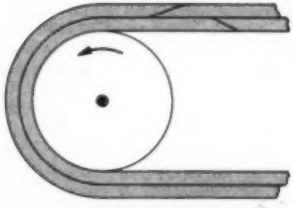
Width of belt	*Lap lengths, in.*
Under 4 in.	4
4 to 10 in. incl.	6
11 in. and over	8

TABLE 2—DOUBLE AND THREE PLY BELT LAPS

		Recommended lengths, in.	
Width of belt	*Laps*	*Break*	*Total*
Up to 12 in.	4	4	12
12 to 23 in. incl.	4	Width less 8	Same as width
24 in. and over	2	16	24



Single ply leather belts should run with the grain side toward the pulley



Single and double ply belts run with outside lap pointing away from pulley

Taper on laps should be made even, and the surface must be perfectly beveled

IN preparing laps for endless single belts, the first step is to cut the belt to the length required for the drive plus an allowance for the lap, making sure the cut is square. (Note: Since one lap should not be made over another, this cutoff point should be between existing laps. For this reason it may be necessary to make a lap longer or shorter.)

The belt is then fastened to a bench or table with hand press clamps. A line is drawn across the belt to represent the *heel* of the lap. This line is the beginning of the bevel, and it must be absolutely square with the sides so that the belt will run straight on the pulley. The lap should be beveled in the same direction as the others.

Starting at the heel line the belt is shaved down gradually to the belt end with a belt shaver. The lap should taper smoothly and evenly from the full thickness at the heel to a thin point at the end. A scraper is employed to level off high spots and insure even graduation of the bevel.

In order to make the laps fit perfectly, a belt knife is used to make a feather edge at the point of the lap. The surface of the lap is then carefully roughened with a scratcher and brushed off to assure a clean surface.

Double belt laps have male and female ends and care must be taken to maintain uniform thickness throughout the lap. Bevel direction of laps must be the same throughout the belt.

To make a double lap, two single laps are prepared with a break between to stagger the lap in the two plies. For example, consider a belt up to 12 in. wide. Both plies of female laps point toward the outside (grain) surface of the belt. First square off female lap end. Then with a screwdriver or lap opening hammer separate the plies to about 15 in. (3 in. longer than over-all lap length.) Squarely cut off 8 in. (length of lap plus break) from one ply. Bevel a 4 in. lap on each ply of female end, similar to single belt laps.

For male end, measure from the front point of the female lap a distance on the belt equal to calculated belt length, then measure off an additional 12 in. (over-all lap length). The belt is cut squarely at this point and 4 in. bevels are made to fit those at the female end. All laps must fit smoothly and evenly. Before cementing, scratch and clean the surface. For ease in splicing, the long side of the female lap should be on top.

Preparation of the endless lap for 3-ply belts is the same as for a double belt. In opening the plies for female end, separate only the top ply from

Laps for double or triple ply endless belts are best made according to the illustration on the left. The

alternate method, right, is satisfactory when belt is short. The life of the lap depends on cemented area

After clamping and locating the heel, the lap is beveled to a smooth taper

Uneven spots are leveled with a scraper, which is drawn toward the thin edge

Feather edging laps assure a perfect fit, and roughening aids cement bond

middle ply. The two bottom plies are separated and are handled as one ply similar to a double ply belt.

Quick drying and waterproof cements are available for making leather belts endless. Quick drying is preferred wherever belts are not exposed to moisture or water. Waterproof cement requires longer drying time but is necessary wherever belts are exposed to moisture or water.

For a lap to be cemented with non-waterproof cement, prepare the lap as previously described. Place the vessel containing the cement in a kettle of boiling water, reducing the cement with hot water to the consistency of light molasses. The cement should be hot—not boiling—and not too thick.

Cement is applied with a brush, rubbing it well into both surfaces of the lap. The glued surfaces are placed together and the laps rubbed hard with a slicker. Laps may be pounded with a pounding hammer to make the glue take a good grip.

Small laps may be fitted all at once, but for wider belts only about 6 in. at a time should be glued. After each application of glue the belt should be rubbed and hammered. The laps should set for about ½ or ¾ hr in an ordinary dry atmosphere and for at least 2 hr in damp atmosphere before starting the belt. A little longer time to set is desirable when convenient.

When using waterproof cement, uniform pressure must be applied and maintained until the cemented lap is dry. Smooth boards held by hand clamps are adequate for belts under 12 in., but a press clamp is necessary for belts 12 in. and wider.

A sizing coat of cement should be applied to the entire lap. This is thoroughly worked into the fibres and allowed to dry—at least a half hour is necessary. When the surface does not become glossy when dry, another sizing coat is required. After obtaining a gloss finish, an even coat of cement is applied to every part of the lap surface, as far as the press clamp will permit—usually about 1 in. less than the length of the clamp. The cemented section is then clamped and screwed down tightly. The joint is allowed to set for at least a half hour before the press clamp is moved back the required amount. This procedure is repeated until the entire lap has been securely cemented.

Waterproof cemented laps should never be pounded. When clamps are not available rub firmly and evenly with a slicker, rubbing from heel toward point of lap. Belts with newly cemented laps should not be put under tension until thoroughly dry. This is from 3 to 6 hr, but drying conditions will govern the exact length of time.

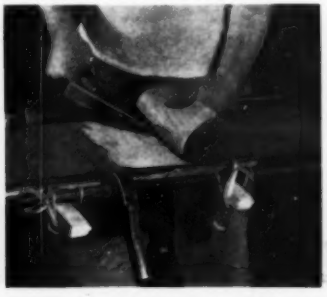
When wide belts are to be installed endless on pulleys or when they have to be shortened, clamps and rods must be used. Ends of new belt or lap of old belt should be brought to the most convenient position for cementing. One clamp is placed 6 in. back of the female lap and the other at the extreme length of the rods. To allow for slack between clamps, the belt is drawn tighter than running tension.

A board, just wide enough to fit between the belt clamp, is strapped to the rods as a rest for beveling and fitting the lap. Before cementing the lap, check to see that the belt is perfectly straight. Adjust one rod and refit lap if alignment should require.

In shortening an endless belt, adjust the clamps and open the lap by inserting screwdriver and lap-opening hammer. Tighten the belt to proper tension and cut out the excess leather, making a new lap. The old glue is then scraped from female end, and both ends cemented as previously described.

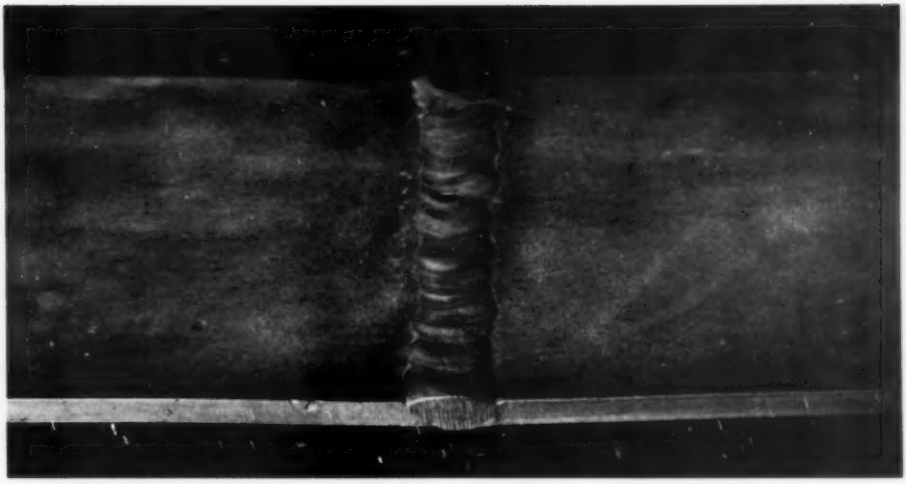
Acknowledgment is made to Graton & Knight Co. for data in this article.

When removing or shortening a belt, start opening lap with a screwdriver



Remainder of lap is parted with a lap-opening hammer to prevent tearing

Excess leather is cutout and male lap made. Female is cleaned for cementing



The practice of welding bus bar, as well as many other electrical connections, is rapidly growing, especially in the process industries using much electrical energy. Several processes, including those using silver- and phosphorus-copper brazing alloys, are suitable for plant operations

Select the Right Process and Material for JOINING COPPER AND ITS ALLOYS

Equipment manufacturers are producing satisfactory joints in copper and its alloys by methods which are generally suitable for installation, alteration and maintenance in plant services. Success depends on matching process and filler rod or electrode to base metal, and on readily learned techniques

JOSEPH IMPERATI, *Welding Engineer, The American Brass Company*

COPPER AND ITS ALLOYS are widely used for electrical, power, and process equipment. In one or another of the alloys available, it is possible to get the strengths required in combination with superior corrosion resistance, high thermal and electrical conductivity, and good fabricating properties. Most of them also have excellent ductility at both normal and low temperatures.

The range of applications is wide, as for instance, in bus and other electrical conductors; in piping and condenser tubes; in shells and other components for tanks, pressure vessels and heat exchangers; in screens, gates, and the like; for sewage disposal and water works equipment; and in a host of other uses. Brief descriptions of the major alloy groups are given in Table 1.

Silver Alloy Brazing

Alloys listed are readily joined by silver brazing with the standard alloys and the usual fluxes. However, the aluminum bronzes of Group 7 (a) require more active fluxes than needed for the other alloys to insure removal of their refractory oxides, and special fluxes have been developed for the purpose. Careful cleaning, fluxing and temperature control are important. Silver brazing materials with high phosphorus content should not be used on the nickel alloys because they may produce brittle joints.

Brazing and Braze Welding

Most of the alloys are also easily brazed and braze welded with the braze welding rods shown in Table 2. Exceptions are the copper-silicons of Group 2 and the aluminum bronzes of Group 7 (a), the oxides of which may prevent complete bonding unless special, very active, fluxes are used.

Brazed joints depend for strength on the shear resistance of a thin film of the brazing alloy which has been drawn in between closely-fitted surfaces. In *braze welded joints*, the alloy is deposited in open V-grooves without melting the base metal. With the reinforcement left on, such joints easily develop the full strength of the annealed base metals.

While brazed and braze welded joints can develop satisfactory strengths, the base material is often selected for corrosion resistance, and that of the brazing alloy under the proposed service conditions should be considered so that there is no failure at the joints.

The metal arc process, used here on 70-30 cupro-nickel, is limited to a few alloys. Other methods allow better control of heat-input to deposited-metal ratio, improving fusion

Inert gas shielded processes provide excellent quality. The tungsten arc process is shown being used on deoxidized copper. Preheating from below speeds welding on heavy section

Welding Copper Alloys

All of the alloys can be welded by one method or another. Rods and electrodes most commonly used fall into the general classes of Table 2, shown with their AWS designations and approximate compositions. Uses are discussed under the following base metal groupings.

Group 1—Copper

The two grades of copper most familiar to fabricators are in this group. Both can be welded, but only with deoxidized copper is it possible to obtain maximum strength and ductility in the joints. For the same weld qualities on tough pitch copper, joints must be hot-hammered because this material has the minute particles of copper oxide scattered throughout its structure. This oxide does not affect the physical and electrical properties of the wrought metal, but at temperatures above 1300 F, it collects at grain boundaries to produce some weakness there. Then, if hydrogen is present in the welding atmosphere (and this is especially true in oxy-acetylene welding) it diffuses into the hot copper and reduces the oxide. The resulting superheated water vapor, or steam, disrupts the structure and weakens it further.

Deoxidized copper is free of oxides and has some residual phosphorus which prevents their formation during brazing and welding. This grade is usually specified for pressure vessels and other process equipment fabricated by brazing and welding.

Copper is most often welded with the oxy-acetylene and inert gas tungsten arc (non-consumable electrode) methods. Requirements for successful oxy-acetylene welding are: (a) flux applied to both rod and work, (b) slightly oxidizing flame adjustment, (c) pre-heat ahead of the welding flame, especially on work over ¼ in. thick, and (d) the right welding rod. This method is relatively easy to control, even in vertical welding.

The inert gas tungsten arc, although generally limited to downhand welding, is probably more widely used now than the oxy-acetylene method. The preferred shielding gas is helium because it develops far greater weld metal fluidity and requires much less preheat than argon. Straight polarity direct current is used.

Several types of copper welding rods have been in common use with these methods. Among them are (a) phosphorus deoxidized copper, (b) a 1 per cent silver-bearing copper, and (c) an alloy with about 0.3 per cent silicon. The last is the only one capable of developing fair strengths and minimum porosity.

A most successful patented filler metal alloy, with nominal copper content of 98.8 per cent copper, has been developed by addition of tin and manganese to the silicon-bearing alloy. It consistently develops the full strength of annealed copper, excellent ductility and maximum soundness, without the need of hammering the welds. Welds made with this filler metal on deoxidized copper readily meet the requirements of the ASME Code for Unfired Pressure Vessels where copper has been approved, namely for Paragraphs U-69 and U-70.

The inert gas shielded automatic arc methods (consumable electrode, automatically fed) are now being successfully applied to the welding of copper. Excellent results are obtained when using an electrode wire of the patented alloy described above.

The carbon arc method is sometimes used to weld copper and has advantages of good speed and easy control. However, copper rods cannot produce sound weld metal and the method is limited to cases where a filler rod of phosphor bronze (R Cu Sn) or copper-silicon alloy (R Cu Si) can be used.

The metal arc method is not used for any important work because of difficulties brought on by the high heat conductivity of copper. It is necessary to preheat to very high temperatures to minimize the formation of cold laps and slag inclusions, and the high current densities required cause excessive spattering and poor control.

Group 2—Copper-Silicon Alloy

Of all the copper alloys, this class, which includes Everdur 1010, Herculoy 420, Olympic Metal Type A, and others, is probably the most widely used for process equipment because of its corrosion resistance and excellent weldability by all methods. The filler metals (R Cu Si, E Cu Si) have compositions practically identical with the base metals and there is thus no question about adequate corrosion resistance in the welds.

The method most widely used is the

inert gas tungsten arc with straight polarity direct current. Shielding gas may be helium or argon with a slight preference noted for the former. The inert gas shielded automatic process is also being used with excellent results. The inert gas processes make it relatively easy to develop the maximum strength, ductility and soundness in the welds, and to meet consistently all ASME Code requirements.

Formerly the oxy-acetylene method was widely used where maximum ductility and soundness were required. Flux is required on both work and filler rods. Although still dependable, it has been largely supplanted by the faster and more efficient inert gas methods.

The carbon arc method has also been widely and successfully used for the fabrication of process equipment. In Code work, it has been restricted to uses covered by Paragraphs U-69 and U-70. Although being replaced by the inert gas methods when the highest weld metal quality is required, it is still useful for many less critical applications and has the advantage of being easier to control and less costly. A flux is necessary on base metal and welding rod; the one commonly used is 90 per cent fused borax and 10 per cent sodium fluoride mixed with alcohol and painted on lightly.

The metal arc method is not widely used. Although several flux coated electrodes are available, none is capable of depositing the high quality weld metal usually required. Therefore, most process equipment is fabricated by the other methods described.

Group 3—Phosphor Bronze

The phosphor bronze usually specified for use in welded fabrication is alloy A which contains four of five per cent of tin. Most welding is done with flux coated electrodes having core wires of the same alloy, available from several sources. These electrodes are suitable only for downhand welding. The base metal must be preheated to about 600 F for maximum control and minimum spatter. Full strength of the annealed base metal can be developed with metal arc electrodes.

The carbon arc method has often been used with bare filler rods with composition similar to the base metal. Control of weld metal is easier than with the metal arc method, but welding is still limited to the downhand position. It has not been possible to develop more than 75 per cent of the base metal strength. Fluxes are not used, the phosphorus in the alloy acting effectively as one.

The inert gas tungsten arc method has been used with moderate success. Special filler rod alloys, not yet available, may be found necessary to develop maximum strength, ductility, and soundness with this method.

The inert gas shielded automatic methods have been tested for certain overlay applications. Filler wires of the 5 per cent alloy appear to produce results that will be satisfactory for welding the alloy A base metal.

The oxy-acetylene method is not used for this alloy. Excessive weld metal porosity results in low strength and ductility in the joint.

Group 4—Red Brass

Welding rods of red brass cannot be used to weld this alloy because of excessive weld metal porosity, hence none is available. However, the oxy-acetylene and carbon arc methods are sometimes used with copper-silicon (R Cu Si) filler rods. Welding is very difficult in positions other than the horizontal. The inert gas, tungsten arc method may be used, although it offers no advantage since it cannot suppress vaporization of zinc from the base metal.

Group 5—The Cupro-Nickels

Excellent resistance to salt-water corrosion makes these alloys widely used for marine applications, such as condenser tubes, evaporators, condensers, salt-water lines, etc. Most widely used is the 70-30 alloy, but one with only 10 per cent nickel plus about 1.5 per cent iron is now being substituted wherever possible to conserve nickel.

Most of welding of the 70-30 alloy is done with the metal arc method using flux coated electrodes. They are

TABLE 1—COPPER ALLOY BASE METALS

Alloy group	Composition, per cent		Name, specifications, uses
1 (a)	Copper, 99.9 min		Tough pitch copper, ASTM B152 and Type ETP. Used mainly for electrical conductors.
(b)			Deoxidized copper, ASTM B152, Type DHP, sheet and plate for welded construction. Annealed strength is 30,000 psi min. Most pipe and tubing is also deoxidized copper.
2	Copper, 94.8 min Silicon, 2.8 to 3.6 Iron, 1.6 max	Manganese or zinc, 1.5 max or tin, 0.7 max	Copper-silicon alloy plate and sheet. ASTM B96, alloy A. Annealed strength is 50,000 psi min. Tubes are of same composition but covered by other specifications, like AMS-4665.
3	Copper, 93.8 min Tin, 3.5 to 5.8	Phosphorus, 0.03 to 0.35	Phosphor bronze plate and sheet. ASTM B103, alloy A. Annealed strength is 40,000 psi min.
4	Copper 84 to 86	Zinc 14 to 16	Red brass pipe and tubing. ASTM B43 and B135, alloy No. 2.
5 (a)	Copper 65.0 min Nickel 29 to 33	Manganese 1.0 max	70-30 cupro-nickel plate, tube sheets, tubes, salt-water lines. ASTM B122, B171 and B111; Navy Dept. 46C6 and 44T40. Annealed plate strength is 45,000 psi min.
(b)	Copper 86.5 min Nickel 9 to 11	Iron 1 to 1.75 Manganese 1.0 max	90-10 cupro-nickel sheet, plate, tube. Specification MIL-C-15726. Annealed plate strength is 38,000 psi min. Tubes covered by ASTM B111.
6	Copper, 58.0 min Zinc, 38 to 42	Tin, 1.2 max	Naval brass, Admiralty metal, Muntz metal sheet and plate. ASTM B171. Minimum annealed strengths are naval brass 50,000 psi, Admiralty 45,000 psi, Muntz 50,000 psi. Manganese bronze covered by Federal Specification QQ-B-721 a, Class A. Minimum annealed strength 57,000 psi.
7 (a)	Copper, 81.0 min Aluminum, 6 to 11	Iron, 3.5 max Nickel, 7.0 max	Aluminum bronze sheet and plate. ASTM B169, alloy C and D. Minimum annealed strengths are alloy C 50,000 psi, alloy D 70,000 psi. Also B171, annealed strength 90,000 psi min.
(b)	Copper, 76.0 min Zinc, 22.0 max	Aluminum, 1.8 to 2.5	Aluminum brass condenser tube, ASTM B111.

TABLE 2—COPPER ALLOY WELDING RODS AND ELECTRODES

Name and AWS Classification	Composition, per cent (maximum except as noted)								
	Cu, min.	Zn	Sn	Si	Mn	P	Fe	Ni	Al
Copper (R Cu) (E Cu)	98	—	1.0	0.5	0.5	0.15	—	—	—
Copper Silicon (R Cu Si) (E Cu Si)	94	1.5	1.5	2.5 / 4.0	1.5	—	0.5	—	—
Phosphor Bronze A (R Cu Sn) (E Cu Sn)	94	—	4.0 / 6.0	—	—	0.3	—	—	—
Cupro Nickel (R Cu Ni) (E Cu Ni)	67	1.0	1.2	0.5	1.25	0	—	29.0 / 33.0	—
Naval Brass* (R Cu Zn - A)	57	Bal.	0.25 / 1.00	—	—	—	—	—	—
Manganese Bronze* (R Cu Zn - B)	56	Bal.	0.50 / 1.00	—	0.01 / 0.50	—	0.25 / 1.00	—	—
Low-Fuming Bronze* (R Cu Zn - C)	56	Bal.	0.75 / 1.10	0.04 / 0.25	0.01 / 0.50	—	0.25 / 1.00	1.00	—
Nickel Bronze** (R Cu Zn - D)	45	Bal.	—	0.04 / 0.25	—	Some	—	9.0 / 11.0	—
Aluminum Bronze (R Cu Al - A) (E Cu Al - A)	87	—	—	0.55	—	—	5.0	—	6.0 / 11.0

* Braze welding alloys (formerly bronze welding). Also extensively used for joining iron and steel.

**This alloy can be used to braze the cupro nickels. It is mainly used for brazing and braze welding steel.

R—Uncoated filler rod. E—Coated arc welding electrode.

available from several sources and have been accepted for compliance with Bureau of Ships specification, 46E5. They easily develop the full strength of the annealed base metal.

In the thinner gages, the alloy is sometimes welded with the oxy-acetylene method using a patented filler rod of the 70-30 composition which has alloying elements added to help obtain sound weld metal. A flux is required on both filler rod and work to insure oxide-free welds. Fluxes used for monel metal are suitable.

90-10 cupro-nickel is successfully welded with the metal arc method using the coated 70-30 electrodes mentioned above. In addition, satisfactory electrodes with core wires of the 90-10 alloy have been developed.

Oxy-acetylene welding of the 90-10 alloy is not practicable due to the lack of a suitable welding rod.

The carbon arc method cannot be used for welding cupro-nickels because it produces excessive weld-metal porosity.

The inert gas processes are being investigated with the object of developing suitable welding rod and filler wire compositions.

Group 6—Naval Brass, Etc.

Welding of these alloys is done with the oxy-acetylene method using filler rods of the three braze welding alloys, R Cu Zn—A, B, and C. However, only the low fuming type, R Cu Zn—C, can be used if welds of maximum strength, ductility and soundness are required. Both work and welding rods should be fluxed using the ordinary braze welding fluxes.

The arc welding of these alloys is difficult because of the large volumes of fumes produced, and is attempted only where the oxy-acetylene method is considered impracticable. In some such cases, the carbon arc method has been used with reasonable success. Filler rods employed were phosphor bronze (R Cu Sn), copper-silicon alloy (R Cu Si), and the flux coated aluminum bronzes (R Cu Al—A). In a few cases, the metal arc method and the flux coated aluminum bronze electrodes (E Cu Al—A) were successful. For the latter, some preheat is desirable to reduce current densities and consequent spatter loss.

Inert gas shielded automatic welding has been used on the high zinc alloys and very good results are reported when filler wires of aluminum bronze are used. As more applications are tried, it may be shown that zinc fumes can be materially reduced by careful control of welding procedures.

Group 7 (a)—Aluminum Bronze

This group includes three major alloys: (a) 92 Cu, 8 Al (B169, Alloy C); (b) 7 Al, 2.5 Fe, balance Cu (B169, Alloy D); and (c) 9.5 Al, 5.5 Ni, 2.5 Fe, 1.0 Mn, balance Cu (B171, aluminum bronze). They are difficult to weld because of the refractory oxides which form on the molten metal. Control of the oxides requires fluxes high in fluoride content.

It has been common practice to weld these materials with the metal arc method using flux coated electrodes and the carbon arc method with flux coated filler rods. Although electrodes and rods are made with aluminum contents up to 13 per cent, welding is usually done with those containing 7.5 to 10 per cent aluminum. Weld strengths vary from 55,000 psi up, depending on the base metals used.

The inert gas, tungsten arc method has proven only moderately successful

Deoxidized copper, joined by the oxy-acetylene process, was used to fabricate the elbows, adapter, header and expansion joint. Note that the relatively light copper is reinforced with heavier material at some of the flanges for strength

because of difficulty of making welds consistently free of tungsten inclusions. Direct current welding, although free of tungsten inclusions, is hampered by a heavy interfering film on the weld metal, regardless of the shielding gas used, and is limited to thin metal. Welding with alternating current is somewhat easier. However, with the argon shielding there is still some interference from the oxide film, and with helium there is the possibility of excessive inclusions although fluidity is improved.

The inert gas shielded automatic methods have proven the most efficient on these materials. Welds are clean and sound and show excellent strengths. Welding is done with reverse polarity, direct current using argon or mixtures of argon and helium. Filler wires are regularly available with aluminum content of 9 per cent maximum and iron from 0 to 1.5 per cent. Compositions with higher aluminum and iron contents may be obtained through special arrangements.

The oxy-acetylene method has not been successful on the aluminum bronzes because of inability to control the oxides formed.

Group 7 (b)—Aluminum Brass

This alloy is used mainly for condenser tubes. Welding procedures and welding rod have not been developed.

WELDING OF PIPE

In welding pipe and tubing, including that fabricated from sheet metal, use is made of the procedures outlined above under the several materials headings. Generally, welding is done only in the downhand position, with circumferential joints being rotated. Welding in the vertical position is possible but rather difficult. Overhead welding is practically impossible to do consistently well. The one marked exception is the case of the 70-30 cupronickel with the metal arc method, for which satisfactory flux-coated electrodes have been developed.

In most cases it is extremely difficult to control weld metal to obtain uniform and complete fusion of the joints without developing heavy icicles on the root side. Therefore, backing rings must be used or the joint design based on an allowance for unfused roots. The one exception is on copper-silicon alloy welded with the oxy-acetylene or carbon arc methods. Here the relatively sluggish weld metal makes control possible, allowing uniform and complete fusion without icicles.

Because of the obstacles noted, pipe and tubing are quite often joined by brazing with the silver-brazing alloys. In addition, where service conditions allow, brazing can be done with the copper braze welding alloys (R Cu Zn A, B and C) to take advantage of the lower costs of such work.

WELDING OF BUS BAR

It is often desirable to substitute welded joints for the costly and bulky mechanical joints which have been standard practice in most bus bar installations. It is entirely practicable to weld copper bus bar by the methods described above, especially inert gas.

In the rapidly expanding electrolytic processing industries, very substantial quantities of copper bus bar are regularly welded by the inert gas shielded automatic arc methods. The filler is the patented copper-tin-silicon-manganese alloy which has been so successfully used in welding pressure vessels. Studies of test joints have shown that, although the filler metal has only moderate conductivity, the welded joints usually add less than 1 per cent to the resistance of the bus bar lengths used. Hence, power losses and overheating due to joints are negligible and it is not necessary to experiment with less dependable filler metal alloys.

Filler rods of this same alloy are also used, as described above, with the inert gas tungsten arc method. Finally, if it is necessary to weld with the oxy-acetylene method, this same filler rod alloy is unexcelled for producing sound weld metal.

OLD HEATING METHOD ANSWERS MODERN PROBLEMS

• The heating system for a new building for the Buick Motor Division presented a problem. Vaporization of cutting oils would result in a deposit of dust and oil on heating surfaces subject to air circulation, causing a drop in heat output and requiring regular cleaning which would not only be time consuming but also might interfere with production.

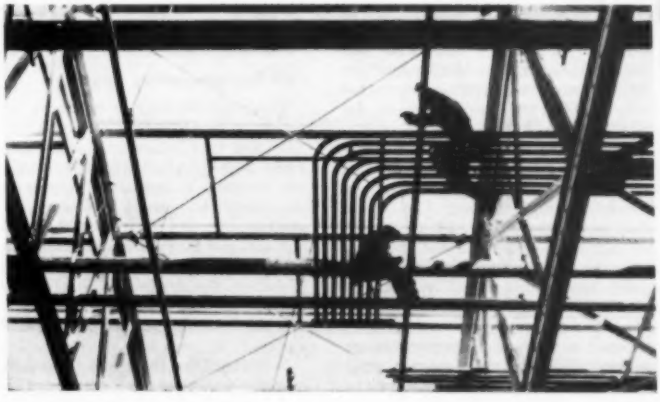
Consequently, engineers based design of the new system on one installed in 1908 in another building. It consisted of overhead wrought iron pipes fastened to ceiling joists, and has served to this date without serious maintenance difficulties.

The new heating system basically consists of parallel runs of wrought iron pipe, totaling more than 75 miles in length, through which hot water is circulated. The result is a giant, ceiling-hung radiator that is easily maintained and kept clean, and is out of the way for extensive remodeling required when a new design is adopted.

Modern innovations include control coordinated with outside temperature. The coil water heat is regulated from another building where an indicator records outside readings, as well as that of the inlet and outlet of the heat exchanger connected to the steam and water lines. The exchanger outlet temperature is varied inversely as the outside temperature according to a linear chart relationship, and by manual means. Size of the pipe limits water to 200 F with steam valve open.

The new building measures 700 by 1200 ft and covers more than 19 acres.

Supplied through the courtesy of the A. M. Byers Company.



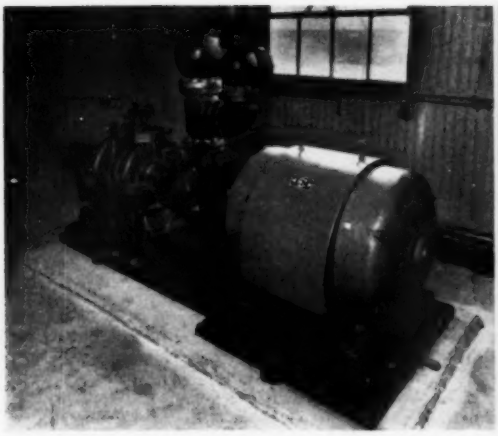


Fig. 1—The most familiar frame construction is found on the bracket type motor with bearings mounted in the end bells. Used for normal applications and speeds in sizes to 4 ft

Fig. 2—As opposed to the bracket type, the pedestal construction has bearings mounted separately from stator frame. Used in large frame diameters and many special applications

How the Application Affects

MECHANICAL FORMS OF

Here is a survey of the mechanical variations found in large a-c motors. Design of frame, bearings, cooling system and enclosure is generally affected by the application or surrounding conditions, and should be anticipated in the preliminary stages of selection. This

LARGE A-C MOTORS are supplied in a variety of forms, depending on motor horsepower and speed, type of driven machine, and on ambient conditions. Motors may be horizontal or vertical, depending on whether the shaft rotates about a horizontal or vertical axis and they may be coupled, belted or mounted directly on the driven shaft.

Various types of enclosures are available to fit specific surroundings. They may range from those designed to protect the motor in case of actual submergence, through those which protect against explosive, corrosive, abrasive or dirty conditions, to those whose whose prime purpose is to facilitate dissipation of heat.

High speed motors for belting or direct connection to the load are usually of the so-called "bracket" type having their bearings in end bells attached to the motor frame. Motors 500 rpm or above, and in frames about 48 in. in diameter or less, are usually of this construction, Fig. 1. Motors built on larger frames and motors for operation below 500 rpm are usually of the pedestal type, Fig. 2.

Either bracket or pedestal type motors may be used for belted service, belt tightening rails being provided to maintain proper tension. For severe duty and extreme belt pull, an extended sub-base and outboard pedestal bearing is recommended. Likewise either bracket or pedestal type may be coupled to the driven machine, a flexible coupling being preferred.

Small reciprocating compressors are generally belt driven. Common practice for units operating at 600 rpm or less is to have the motor rotor mounted on the compressor shaft.

In the common "engine" type motor, Fig 3, the stator frame rests on soleplates grouted into the foundation. A more special application is the "flange" type, Fig. 4, in which the stator frame is bolted to a flange on the compressor frame.

For Reciprocating Loads

Provisions for high rotor inertia are necessary for reciprocating loads.

Engine type rotors are usually provided with split hub, Fig. 5, to facilitate assembly if they are overhung on the compressor shaft extension. If mounted between crank discs, the rotor hub and rim are split as also shown in Fig 5. The rim is held together by the H-shaped shrink links visible at top and bottom, just inside the field coils. The bolts joining the split hub are also visible.

Sometimes the rotor hub is used to couple together the shaft extensions of two vertical compressors, Fig. 6. In such cases the rotor is always completely split. The stator is also split when necessary to facilitate installation.

The smaller, high speed, flange type motor rotor is either a light drive fit on the compressor shaft, or is provided with tapered bore to match a tapered shaft extension. It is held in place by a lock nut.

Bearings may be either anti-friction or sleeve bearing type. Small, high speed ratings are quite universally equipped with anti-friction bearings, particularly in speeds of 1800 rpm or less. Most large units, most motors at 3600 rpm, and heavy duty motors operating below 500 rpm have sleeve type bearings.

Rolling Mill Applications

Steel rolling mill motors have sleeve bearings with babbitted thrust faces enabling them to withstand considerable thrust load in case of roll neck breakage. For small, high speed mo-

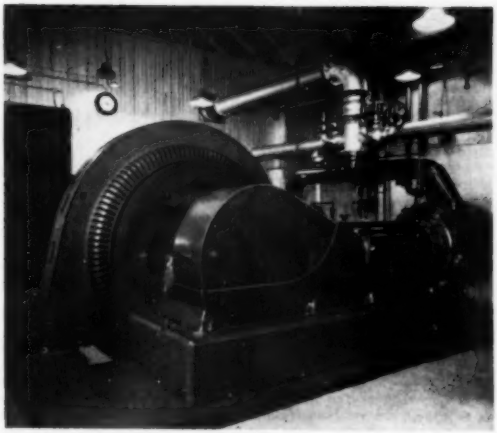


Fig. 3—In the "engine" type motor, stator frame may be like that of pedestal type, but rotor is mounted on the compressor shaft and may be split to facilitate assembly operation

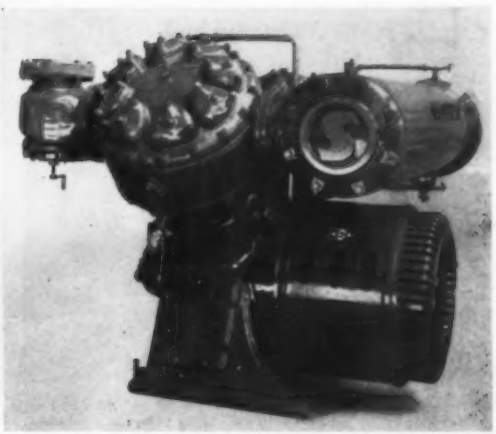


Fig. 4—Small motor-compressor sets, manufactured as a unit, often use flange type motors in which the stator is mounted on the compressor base and the rotor carried on the shaft

THE LARGER A-C MOTORS

is the second article of a series*, and includes the most common physical features that affect motor selection and installation

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tors, which must withstand a small amount of thrust, an angle contact type of bearing, combining thrust and radial loading, is usually employed.

Relatively small high speed vertical motors usually have angle contact ball bearings serving as combined thrust and upper guide bearings, and ball bearings for the lower guide bearings. These bearings are all grease lubricated.

Large, slow speed, vertical motors, Fig. 7, generally have to carry appreciable thrust loads in the form of pump impeller, shaft and hydraulic load. Thrust bearings, of the oil lubricated, sliding shoe type (Fig. 8 shows upper bearing) are always used for heavy loads. Oil lubricated, sleeve type are employed in upper and lower guide bearings.

Vertical motors driving pumps are frequently built with hollow shafts. In high speed construction, the pump shaft passes through the motor shaft and is supported from a thrust nut at the top. This permits vertical adjustment of the pump impeller to center it in the pump casing. Non-reverse ratchets and self-release couplings are also often provided on these high speed units. They prevent turbine action of the water column on shutdown and unwinding of the screw type couplings in the pump shaft.

Hollow Shaft Motors

Large vertical pumps are frequently built with adjustable pitch blades. In those cases, the motor and pump shafts are hollow and are rigidly coupled together. The pitch adjusting means utilizes the hollow portions of the motor and pump shafts to vary the pitch while the unit is operating.

Protective construction will vary widely from industry to industry. Special requirements of some of the principal industries are listed below.

Unless explosive gases are present, engine type and flange mounted compressor motors are normally open style. Inert gas filled motor housings or enclosed separately ventilated motors are used under explosive conditions. In the latter case, Fig. 9, the blower motor providing the ventilating air is interlocked with the compressor motor control causing the blower motor to operate long enough to purge the ventilating system before power is applied.

Splash-proof motors are used in the paper and other industries where splashing liquids may be expected. Beaters, refiners, stock pumps and the like are universally driven by this type. Chipper motors may have guard screens on the side next to the chipper to prevent chips from flying into the motor.

Pulp grinder motor rooms may have several thousand installed horsepower in one room. Removal of heat loss is quite a problem. The common solution is to put discharge ducts on the motors and make them self-ventilating, drawing cooling air from the room and discharging it outdoors, Fig. 10.

The petroleum industry has the problem of explosive and corrosive gases. Explosion-proof motors are frequently used but, for mechanical reasons, the maximum possible frame size is limited. Inert gas filled motors and separately ventilated motors are quite common. In pipe-line stations, the open type is frequently used with a fire wall separating motors from pumps. For outdoor installation, totally enclosed fan cooled, Fig. 11, or weather protected motors are used. All outdoor motors should have space heaters to

* "When to Use Synchronous Motors", INDUSTRY AND POWER, March, 1952

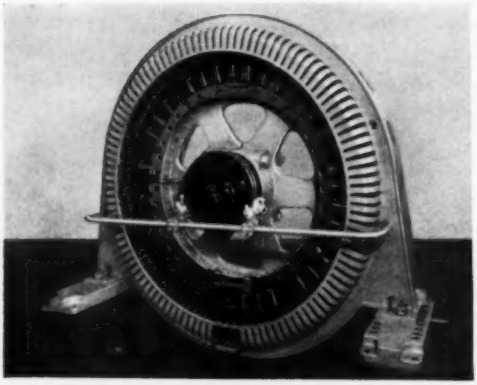

Fig. 5—When mounted on driven shaft, rotor hub may be split for easy assembly. Note hub bolts. Used between dual units, rim is often split. Here, H-shaped shrink bars hold halves

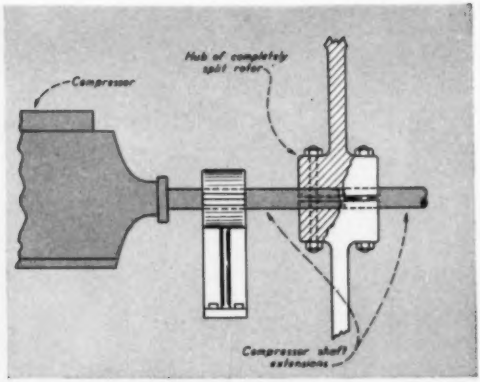

Fig. 6—The sketch illustrates how a completely split rotor may be used to drive two machines. The hub forms a solid connection to both units, eliminates couplings and backlash

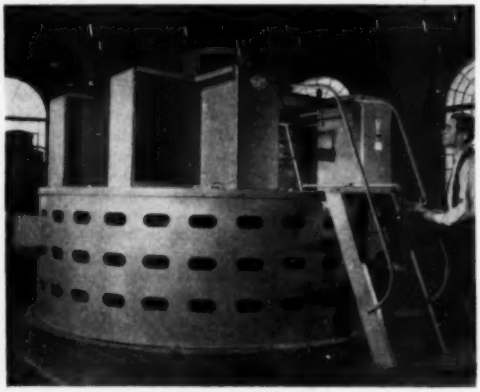

Fig. 7—This 2250 hp, 200 rpm motor is typical of many for high power, slow speed vertical pumping applications. The bearings and shafts may be designed for special conditions

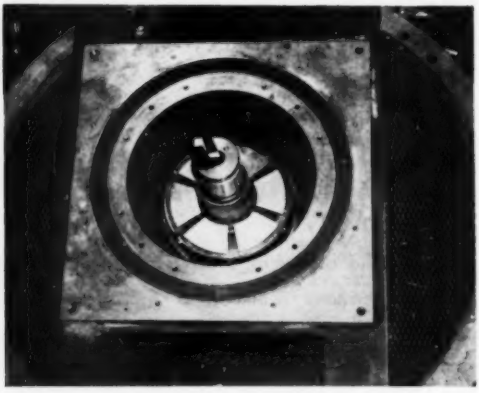

Fig. 8—Upper bearing bracket, including oil reservoir, of a large vertical pump motor showing the six tilting shoes designed for thrust. Guide bearings are also friction type

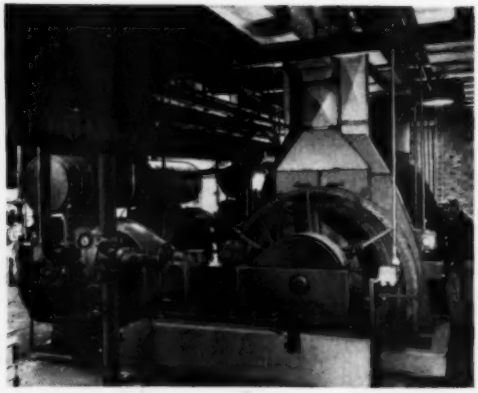

Fig. 9—Under explosive conditions, motor may be separately ventilated. In the above application, blower for cooling air purges system before compressor motor can be started

Fig. 10—Large motors are often installed in separate rooms if dirty or hazardous conditions prevail. The problem of heat removal may be solved by use of outdoor-discharge ducts

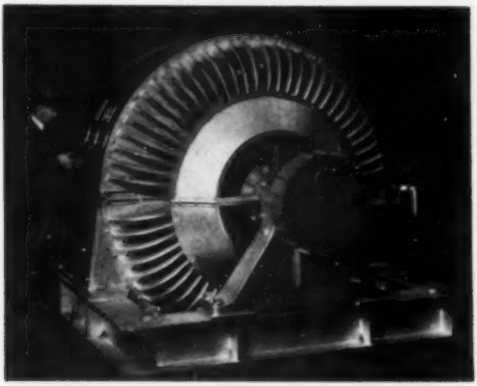

Fig. 11—Totally enclosed, fan cooled motors, above, or the weather protected type may be installed outdoors, often with a considerable saving in building costs or for safety

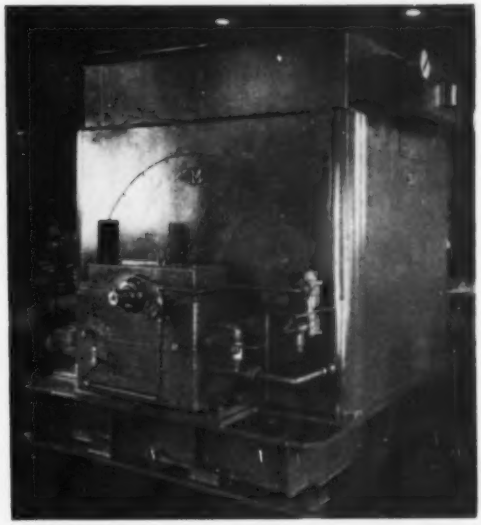

Fig. 12—Many troublesome conditions, such as those harmful to the motor, are combated with special enclosures. Water-cooled heat exchangers cool this totally enclosed motor

prevent condensation of moisture during shutdown.

The chemical industry has the problem of corrosive gases which may attack insulation, collector rings, and other parts. Also certain chemicals used in plastic processing attack insulation. In addition to special insulations to withstand chemical vapors, motor enclosures are commonly used to avoid effects of such conditions.

Dust Protection Methods

The rubber industry has the special problem of large amounts of carbon black in the air. This adheres to motor coil surfaces and is highly conductive. It is especially troublesome in the case of field windings on synchronous motors. Totally enclosed motors, Fig. 12, provided with water-cooled heat exchangers, are becoming popular in the larger sizes to meet this condition.

Where open type motors are on hand, it is quite common to install them in a separate room provided with filters and air removal means.

Public utility generating plants are now making many outdoor installations. Totally enclosed, fan cooled or weather protected motors are being used for this duty. Special boiler room insulation and Class B insulation to meet high temperatures are commonly used in high temperature locations.

Flour mills have highly explosive conditions. In general, the main drive usually consists of one large open type motor. This motor is located in another room separated from the mill proper by a fire wall.

Cement making and rock crushing machinery operate in dust laden air. Frequently, the dust is non-abrasive and is harmful only because it clogs ventilating air passages. In such cases, open type motors which can readily be blown out are recommended. Where the dust is abrasive, totally enclosed motors should be used.

Almost an endless variety of electrical and mechanical modifications are available to the purchaser to best fit the motor to his specific conditions. By proper application and selection almost any conceivable operating condition can be successfully met.

GAS TURBINE MEETS TESTS ON GAS LINE PUMPING

Two gas pipelines, one powered by reciprocating engines and the other by gas turbines, were recently studied by engineers of the Westinghouse Electric Corporation. A 26 in. pipeline using the turbines to drive the compressors was found to deliver the same amount of gas more economically than a 30 in. line powered with conventional engines.

The smaller 26 in. line using the turbines required about $8,000,000 less capital investment and 64,500 fewer tons of steel to build. Annual cost for the line was reduced by about $1,360,000, or 0.8 cents per thousand cu ft of gas pumped.

The gas turbine lends itself to driving a high speed centrifugal compressor. A new concept is created in this field, for the centrifugal type operates more efficiently at lower pressures and permits closer station spacings than reciprocating compressors. Annual delivery capacity for a gas turbine powered line is substantially greater.

If intermediate gas turbine stations are added on a line powered by reciprocating engines, capacity of the line can be increased economically and materially. This is particularly true where it is desirable to boost capacity of existing gas lines to meet wintertime peak conditions. Where summertime dump gas is limited and storage facilities are not available at the distribution point, the gas turbine booster station is an economical way to increase pipeline capacity.

The first experimental gas turbine for land application built by Westinghouse was installed in 1949 in Wilmar, Arkansas, on the Mississippi River Fuel Corporation's gas line, as reported in earlier releases. The purpose was to obtain operating characteristics and information on the gas turbine and its adaptability to gas line pumping.

As a result of its successful operation, the Mississippi River Fuel Corporation purchased the unit early this year. It is now in permanent operation.

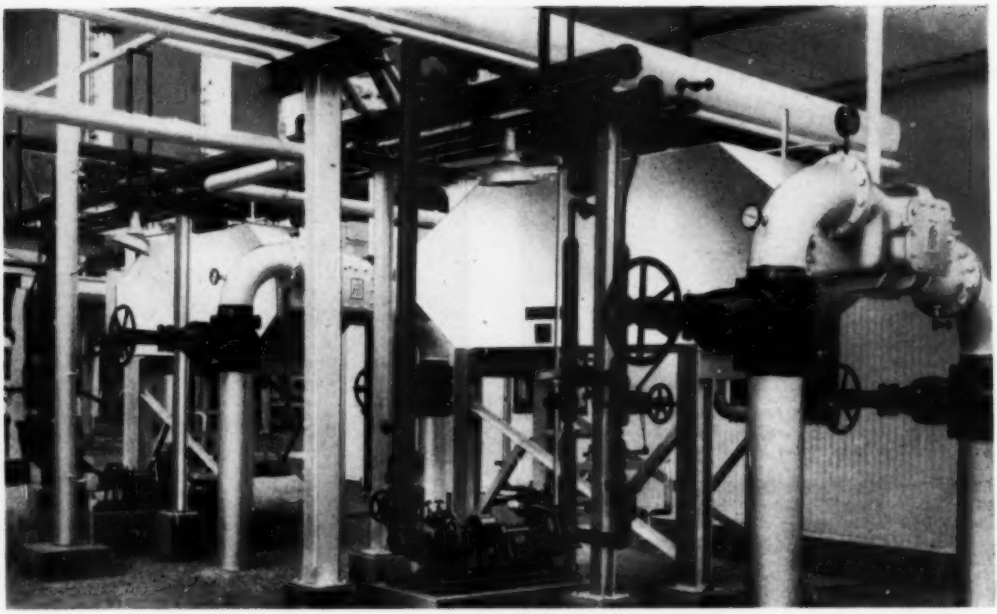

Fig. 1—Efficient utilization of all surface depends on the internal construction. One arrangement for small condensers is shown in Fig. 2

Fundamental Designs and Design Considerations of

Condensers are an important component of numerous industrial installations. This article consolidates basic recommendations for selecting, operating and maintaining condensers to obtain peak performance

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IN THE LANGUAGE of the Heat Engineer, a condenser is any apparatus which can be used to reduce a fluid from its vapor to its liquid state through the removal of heat. The category of industrial condensers is a multiple one and might easily be expanded to include a range from the extreme pressure unit in the oil refinery to the simple copper coil. This article, however, devotes attention primarily to industrial steam condensers that operate under vacuum with water as the condensing medium. Operation under vacuum increases the availability of energy in the steam by reducing the back pressure on the prime mover below atmospheric pressure.

Steam condensers can be classified as; (a) the direct contact type, in which the steam and cooling water are mixed, and (b) the surface type, in which the steam and cooling water remain isolated. Although direct contact condensers have an important place and find wide application in industry, surface condensers assume a leading role because they reclaim the condensate for re-use as boiler feedwater. Thus surface condensers are almost universally employed in most modern steam power plants including central stations of electric utilities, blast houses of steel mills and other industrial installations where the exhaust from steam prime movers must be condensed.

Two small surface condensers serving mechanical drive turbines powering centrifugal blowers in an oil refinery are shown in Fig. 1. Designing and building units of this type economically often presents problems as the tube length is much greater in proportion to the shell cross-sectional area than on larger condensers. Fig. 2 illustrates one means of conveniently utilizing the full length of a small tube bundle. Steam spreads at the inlet and flows down through the first and largest section of the tube bundle, under the tube support plate and up across the tubes in the next section. Then it turns over the succeeding support plate and passes down between the tubes in the last section toward the air cooler and air outlet at the water inlet end. The flow path is progressively reduced in area to compensate for the rapid decrease in steam volume caused by condensation within the unit.

Design Requirements

Numerous factors should be considered and evaluated in order to establish the optimum design requirements of a condenser for a particular

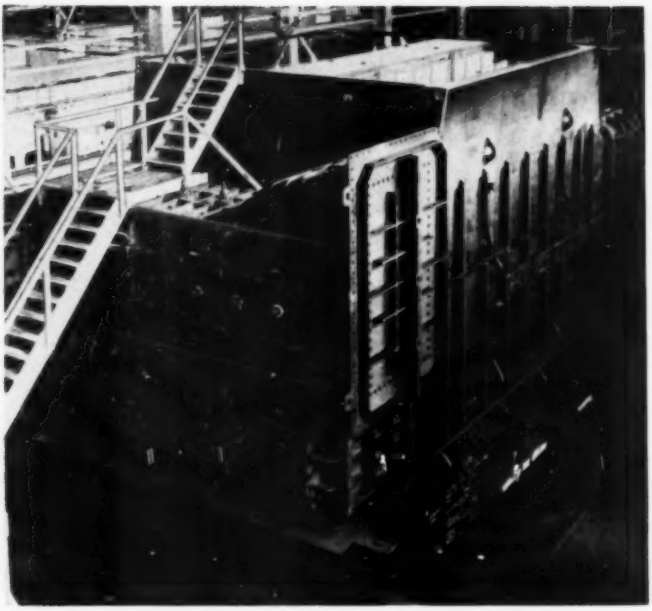


Fig. 3—This large condenser, assembled for factory water testing, is designed to serve a 165,000 kw turbine generator

INDUSTRIAL CONDENSERS

installation. Very often specifications call for a design or guarantee point at some restricted rating, such as maximum load and water temperature, where the condenser seldom operates. Many engineers, however, believe it is advantageous to specify the guarantee point at or near the expected average operating conditions of load and water temperature, preferably with the latter taken as the mean summer average. Then the condenser can be designed for peak efficiency at normal conditions, where it is most important.

Surface condensers,[1] while built in what may be referred to as standard sizes by a manufacturer because they incorporate certain of his standards of water box pattern development, tube sheet and shell cross-section dimensions, are essentially tailor-made equipment. Large condensers in particular present opportunities for varying the details of internal design, construction, layout and erection. One unit, built to serve a 165,000 kw turbine generator, is shown in Fig. 3 as it appeared when assembled for water testing on the shop floor prior to shipment. On large condensers such as this, the designer and consulting engineer must satisfactorily solve many specific problems including; (a) space limitations, (b) methods of support, (c) provisions for connection to the turbine exhaust, (d) arrangement of extraction lines, (e) installation of feedwater heaters in the steam inlet neck, (f) water box design, and (g) means to facilitate orderly field erection. Condenser design is relatively flexible but usually on large units a little "give" is expected on one problem in order to allow the "take" required in the solution of another. Similar or additional problems may be faced on even the smallest units.

Package Condensers

Fig. 4 illustrates one condenser during a running test in the plant before shipment. This type of condenser, sometimes called a package unit, is designed to act as the foundation for the prime mover. In this case, a pipe line centrifugal compressor and its turbine driver are mounted directly on top of the unit. Some auxiliaries and accessories such as air ejectors, turbine oil coolers, panel board and other miscellaneous equipment are also mounted on it to form a unit engineered assembly.

Similar arrangements have been developed for turbine generators. It is suggested that any such arrangement be carefully investigated before arbitrarily selecting it in favor of conventionally designed units. In cases involving blowers with large intake and discharge

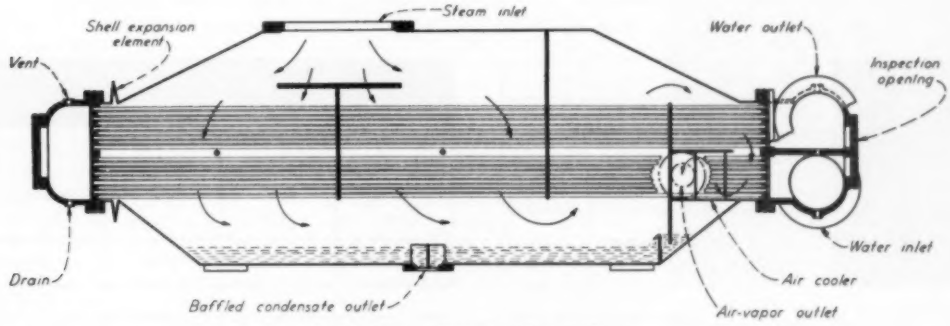


Fig. 2—Cross section of surface condenser

piping standard units are usually best.

Probably 90 per cent of all surface condensers in operation are not performing as well as they should. It must be remembered that the true measure of condenser performance is the over-all heat transfer coefficient or rate of heat flow from the steam through the tube walls to the circulating water, expressed in Btu per hr per sq ft of surface per deg F mean temperature difference. To accurately determine the actual over-all coefficient or rate of heat transfer for a condenser in operation is extremely difficult and, consequently, it is hard to compare actual performance with expected or guaranteed performance. This coefficient is calculated from test readings of; (a) rate of total heat flow to condenser, (b) absolute pressure of steam at condenser inlet, (c) rate of circulating flow, and (d) circulating water temperatures to and from condenser.

Testing Difficulties

In many installations it is quite difficult, and sometimes almost impossible, to get accurate readings of the necessary data. For example, absolute pressure may vary as much as 0.1 or 0.2 in. Hg around the periphery of the steam inlet to the condenser. On one test of a 30,000 kw unit, two properly designed pressure taps were installed at the center of adjacent sides of the condenser inlet. At full load test conditions, two mercury manometers connected to these taps consistently indicated a difference of approximately 0.2 in. Hg in vacuum. Although the taps, manometers and connecting lines were all carefully checked and even switched, the results remained the same. The other two sides of the inlet were inaccessible, so performance was calculated from the average between the two available readings. But this example proves that test results based on readings of vacuum taken at only one location may be inaccurate. There should be at least two, and preferably more, pressure taps spaced around the steam inlet.

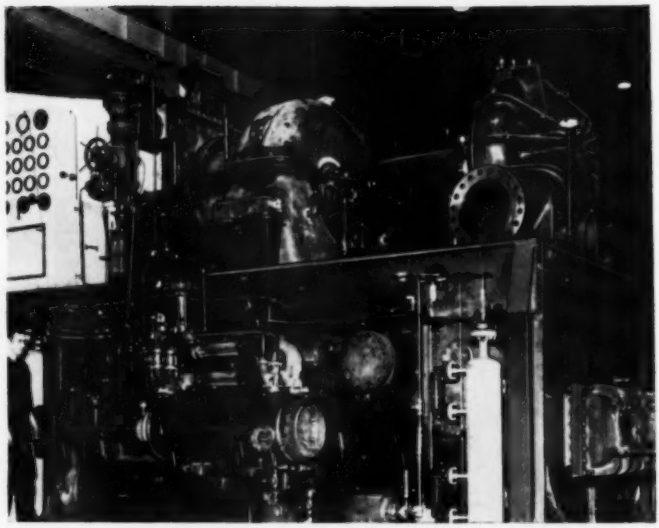


Fig. 4—For some applications, condensers are built that act as foundation for the prime mover as well as providing support for auxiliary equipment

Fig. 5 shows the resulting percentage errors in calculated over-all heat transfer coefficient caused by faulty instrumentation or incorrect readings. For example, at half load and an operating condenser pressure of 1.5 in. Hg absolute, if the pressure was read low by 0.1 in. Hg, the apparent or calculated coefficient would be 60 per cent greater than the actual coefficient. Conversely, if the pressure was read high by 0.1 in. Hg, then the calculated coefficient would appear to be 25 per cent less than the actual coefficient. Corresponding full load percentages are plus 25 and minus 15 per cent but at lower operating pressures the errors are even greater.

Small errors in the observed temperature rise of the circulating water from inlet to outlet will also result in an appreciable error in the calculated coefficient as shown in Fig. 6. For some condensers the error could be even greater than indicated in either Fig. 5 or Fig. 6. Since additional errors may be introduced when measuring net steam and water flow, determining test performance within an accuracy of plus or minus 5 or even 10 per cent may not be as simple as ordinarily considered.

Occasionally operators are willing to accept the measure of vacuum alone as the standard of condenser performance. A unit may be designed for 1.5 in. Hg

Fig. 5—Approximate per cent error in overall heat transfer coefficient as calculated from observed data

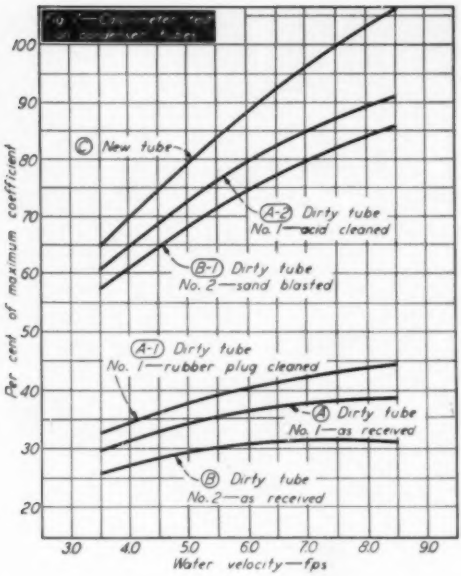
Error in reading pressure	Condenser pressure—in. Hg abs			
	0.5	1.0	1.5	2.0
At half load				
Minus 0.1 in Hg	———	+130%	+60%	+40%
Plus 0.1 in Hg	−45%	− 35%	−25%	−20%
At full load				
Minus 0.1 in Hg	+120%	+35%	+25%	+ 15%
Plus 0.1 in Hg	− 30%	−20%	−15%	− 10%

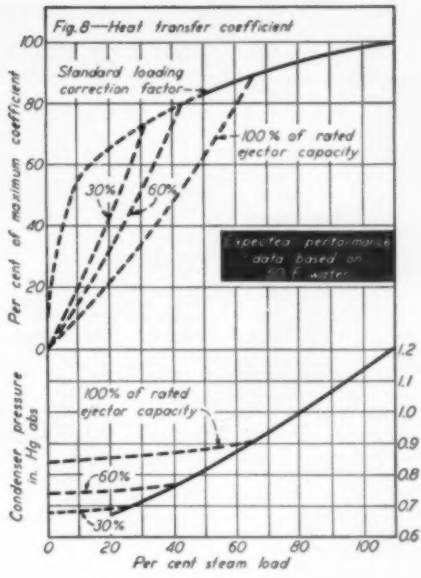
Note: Table is based on full load temperature rise of about 12 deg F and initial temperature difference of about 20 deg F

Fig. 6—Approximate per cent error in overall heat transfer coefficient as calculated from observed data

Error in observed temperature rise at any condenser pressure			
At half load		At full load	
Plus 1 deg F	Minus 1 deg F	Plus 1 deg F	Minus 1 deg F
+21%	−17%	+10%	−9%

Note: Table is based on full load temperature rise of about 12 deg F and initial temperature difference of about 20 deg F


Per cent of maximum coefficient
Water velocity—fps
New tube
A-2 Dirty tube No. 1—acid cleaned
B-1 Dirty tube No. 2—sand blasted
A-1 Dirty tube No. 1—rubber plug cleaned
A Dirty tube No. 1—as received
B Dirty tube No. 2—as received



absolute at full load with 70 F circulating water, leading some operators to believe the condenser is performing as it should as long as the indicated vacuum is 1.5 in. Hg. Actually, this is true only when all other factors are at design conditions. In the wintertime with cold water available, perhaps the pressure should be less than 1.0 in. at full load while this same vacuum may also apply even at design water temperature if the unit is operating at approximately half load.

By being satisfied with an operating pressure of 1.5 in. Hg absolute even though the other factors of load and water temperature are different from the design conditions, operating expenses may be appreciably more than what should be normal. The steam rate of a typical 10,000 kw condensing turbine will be 5 per cent higher if the pressure changes from 1 to 2 in. Hg. Since each ¼ in. increase in back pressure raises steam consumption by 1 ¼ per cent, the turbine generator output would decrease 125 kw for each ¼ in. Hg increase in back pressure. Using a figure of one cent per kw hr, this loss could amount to $1.25 per hr for only ¼ in. Hg higher absolute pressure.

Causes of Faulty Operation

Surface condensers are relatively free from operating and mechanical troubles when compared to some of the other equipment in a power plant. But, as previously mentioned, probably 90 per cent of them do not perform as well as they should. The major causes of this are fouled tubes and excessive air leakage or faulty operation of the air removal equipment. Fig. 7, based on actual results of tubes tested in a heat transfer calorimeter, illustrates what can happen to the heat transfer coefficient due to fouling in operation. Curves A and B at the bottom represent the condition of tubes Nos. 1 and 2 as they were removed from a condenser, while curve A-1 illustrates the improvement in tube No. 1 after it was cleaned by shooting rubber plugs through it four times. In this case evidently rubber plugs were not effective in removing the type of scale present but for slime or mud they are much more satisfactory.

Curve B-1 represents tube No. 2 after the inside was sandblasted, and curve A-2 shows the results of cleaning tube No. 1 in muriatic acid solution. Curve C represents the comparative heat transfer coefficients obtained with a new and clean tube, based on a 100 per cent coefficient at a water velocity of 7.5 fps. Although curves for the tubes as removed from the condenser represent drastically depreciated performance, these conditions are not unusual.

Assuming a surface condenser is designed for 1.15 in. Hg at a representative set of operating conditions, if the maintenance procedure permits the tubes to depreciate from 85 to 70 per cent clean condition, the absolute pressure would increase to 1.26 in. Hg. This same absolute pressure could be obtained by a 20 per cent smaller condenser with corresponding savings in space, cost, and quantity of circulating water, if the tubes were kept clean.

While good inspection and cleaning programs are not free, in many cases their costs are undoubtedly more than repaid by the savings they make possible from reduced turbine steam consumption and associated fuel costs. A possible secondary result of poor maintenance is tube failure caused by partially obstructed tubes. The costs of replacing tubes and the cost of associated outage time may be very high.

The second principal cause of im-

Fig. 9—This photograph shows a reverse flow valve, which is often used to backwash tubes, tube sheets and water boxes

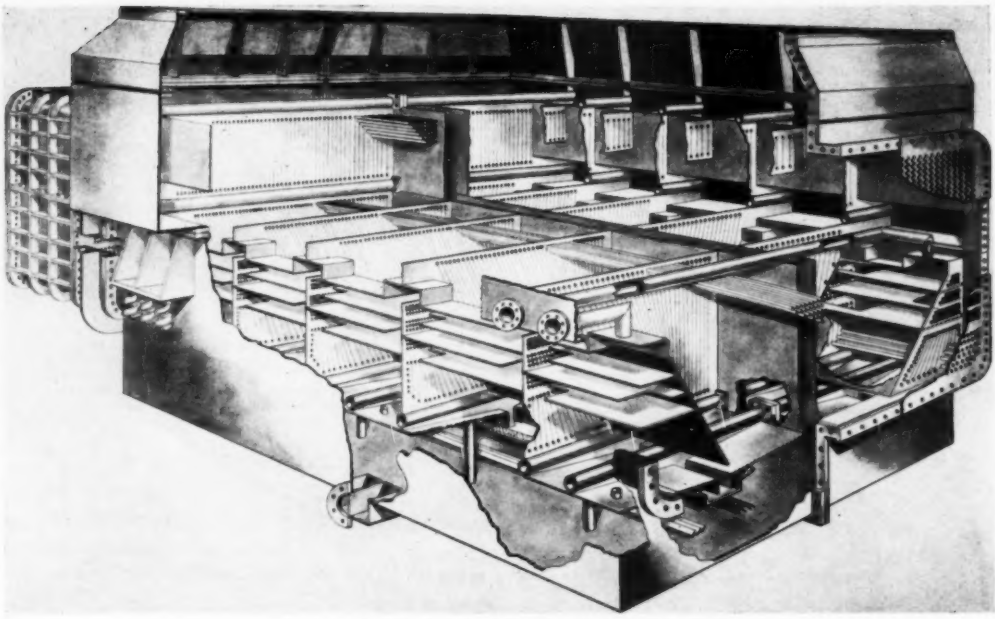


Fig. 11—As steam flows through the condenser, the net area is progressively reduced to insure sufficient velocity to sweep air away from tube surfaces

paired performance is the effect of air either from excessive air leakage or faulty operation of the air removal equipment. This effect is often minimized or disregarded, but it can have major significance in terms of satisfactory condenser performance. Air removal equipment is usually rated to provide reserve capacity over and above the amount of air leakage expected with good operation. It is not expected that condenser performance will always be up to design level when the amount of air to be removed is equal to the full capacity of the removal equipment.

Effect of Air Leakage

Fig. 8 is a graphic presentation of the effect of air leakage on condenser performance, assuming the air removal equipment has a rated capacity in accordance with usual industry recommendations. The cutoff curves at the bottom show the minimum absolute pressures which can be expected at the steam inlet of the condenser with air leakages equal to 30, 60 and 100 per cent of the removal equipment capacity. As the air leakage increases from an assumed normal of 30 per cent, the effect on condenser performance is carried to higher and higher loads although it will vary with temperature, being somewhat reduced when using warm water. However, if the water temperature was much below 50 F and the air leakage approached full rating, the back pressure on the turbine will be determined by the air removal equipment alone and not by the condenser, for the entire load range of the turbine.

The apparent effects on the observed heat transfer coefficient for 30, 60 and 100 per cent air leakage conditions are shown in the upper portion of the graph. These curves give ample evidence that a low coefficient of heat transfer cannot always be attributed to fouled tubes, especially in the reduced load range or when operating with cold water. In fact, air leakage is the first thing to look for when poor performance is suspected. Every condenser installation should include an air leakage meter so readings could be entered on log sheets where any sudden increase in air leakage would be observed.

All this data is based on the assumption that the air removal equipment is functioning properly. Abnormal or faulty operation of the air removal equipment or recirculation of air back to the condenser, for example, through a drain trap, can have even a more serious effect on condenser performance throughout the whole range of operation. Such conditions will not be indicated by readings of air leakage at the discharge of the air removal equipment.

While condenser designs cannot prevent the accumulation of silt, mud or scale on the inner surfaces of the tubes that results from local water conditions, various features have been developed to facilitate cleaning. Water boxes can be furnished with a divided circuit so that one half the water space may be shut down and cleaned while the other half of the condenser carries the load at slightly reduced vacuum. On condensers having sufficiently large water boxes, the covers are equipped with hinged, quick opening manhole doors to reduce cleaning time, and vent connections can be used to facilitate acid cleaning where this method must be employed. Various devices from water box windows and submarine lights to high pressure water jets have been utilized but only experience would dictate the need and effectiveness of these extremes.

In some installations, foreign objects such as cinders, shells, and pieces of coke are likely to lodge in tubes. Unless removed promptly, these obstructions may cause rapid tube failures resulting from deposit attack or impingement corrosion. In other units, especially during certain seasons or in periods of high water, trash in the form of leaves or debris may become plastered against the inlet tube sheet.

One typical type of reverse flow valve that can be installed between the circulating pumps and condenser to permit backwashing of tubes, tube sheet and water boxes as often as necessary is illustrated in Fig. 9. The arrows that

have been superimposed on the photograph indicate the direction of water flow. A pivoted elbow inside the valve body connects the inlet at the front to the top connection on the left, so that the water flows up into the water box, then through the first pass of tubes and back through the second pass. The water discharges from the condenser through the connection second from left, flows around the elbow inside the valve, and down through the outlet at the bottom. By merely swinging the pivoted elbow from the upper left hand connection to the opposite side, the direction of flow through the condenser is reversed, and any trash in the inlet water box is flushed to waste.

During a recent period of high water at a large steel mill the intake screens were damaged, which permitted trash to enter the plant. A condenser equipped with reversing valves, serving a large blast furnace blower, was the only heat exchanger that remained in operation. All other units in the plant served by the river water were shut down due to plugging.

Steam Velocity

Fig. 10 is a section through a typical condenser. The tube rows, represented by slanting lines, converge from the steam inlet toward the air outlet so that the net area is progressively reduced. This is done to maintain the velocity of the steam above the minimum necessary to continuously sweep air away from the tubes and push it towards the air outlet. Regardless of whether the air leakage rate is large or small, the only way to prevent air blanketed surface is to maintain a sufficiently brisk flow of steam across each and every portion of the entire tube bundle. This becomes increasingly important in the direction of the air cooler, since the percentage concentration of the air in the steam increases as the steam condenses.

One of the most critical parts of a condenser is the air cooler section, which serves two purposes; (a) it must have sufficient condensing capacity to assure adequate flow of steam across the tubes immediately preceding it in the main condenser section, and (b) it should be capable of reducing the vapor component of the air and vapor mixture discharged from the air outlet to as low a value as possible. Given air removal equipment will handle a certain rate of air leakage and its associated vapor component at "some" suction pressure and temperature. Inefficient performance of the air cooler section itself will mean that the suction pressure to the air removal equipment will automatically increase to the point where the equipment can handle the amount of vapor left over from the condenser along with the air. Devaporization of the mixture to that point would then have to be partially accomplished by a portion of the main tube bundle. In any event, over-all condenser performance would be impaired and its effect would be felt at the prime mover exhaust.

An interesting example of the importance of air cooler design was gained from a simple experiment on one installation where the air cooler was built in a separate shell external to the main condenser and served by a separate circulating water line. By continuing to operate the condenser and air ejectors normally and merely shutting off the water supply to the air cooler, the over-all performance with and without the air cooler in operation could be easily compared. Under the existing operating conditions with normal air leakage, the over-all heat transfer coefficient dropped 40 per cent, even though the amount of surface in the cooler was a very small percentage of the total.

Devaporization of the air and vapor mixture is accomplished by designing the cooler with successive reductions in the cross section of the net flow path. Thus, a high mixture velocity is maintained, which continuously scrubs the tubes and tends, with the reversals of flow, to precipitate entrained moisture. In this region the flow of the mixture must be held in intimate and turbulent contact with the cooling surface to keep it scrubbed free of insulating air. Multiple vapor passes should be provided to prevent hot streaks of uncondensed steam from short circuiting to the ejectors and overloading them.

Flow Pattern

Fig. 11 illustrates in perspective a condenser of similar design, the portion in the foreground containing the horizontal baffles being the air cooler section. The residual mixture from each individual section along the length of the condenser is led from the last pass of the air cooler for that section into the last pass of the next section. Mixture flow is directed from the warm or far end to the cold water inlet end, which is counter current to the water flow to assure maximum devaporization at the air outlet. The two flanged connections shown in the center foreground are the air outlets, one being for the air cooler section in the far half.

The responsibility of designing and building good equipment rests on the manufacturer, but the burden of obtaining the best performance from a given condenser still rests on the operator. The air removal equipment must work properly, the condenser and entire vacuum system must be kept as airtight as possible, and the tubes should be kept clean. If these suggestions are seriously followed, large savings are inevitable.

The material in this article was abstracted from a paper presented by the author at the American Power Conference in Chicago, Illinois during March, 1952

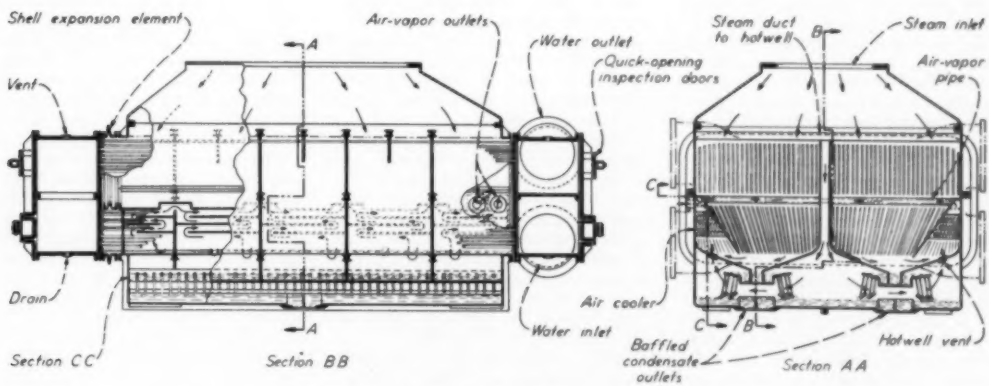


Fig. 10—Cross section of typical large surface condenser

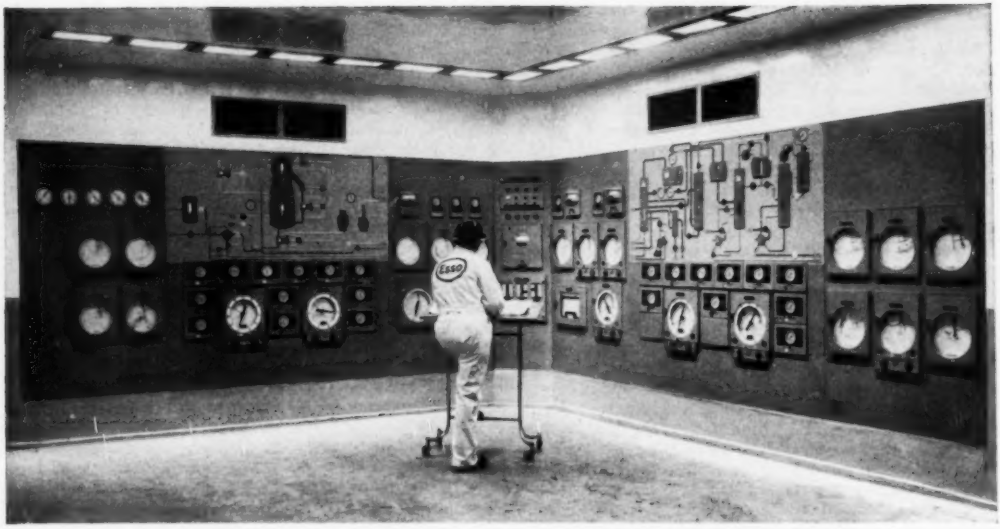


Fig. 1—An entire process is reproduced in a schematic miniature that identifies measurement and control points at a glance. This refinery panel is a semi-graphic type used in many applications

WHERE AND HOW TO USE GRAPHIC PANELS

Graphic panels are not new but their use is rapidly expanding following the advent of miniature instruments and controllers. This survey of their purposes and applications will help decide their feasibility in your plant

E. A. MURPHY, *Brown Instruments Division*
Minneapolis-Honeywell Regulator Company

INDUSTRIAL instrumentation has undergone many changes during the past 15 or 20 years. Accuracy has been improved, speed of measurement has been increased, ranges have been extended, and isolated recording or controlling instruments, scattered at numerous locations throughout a plant, have been largely supplanted by the modern centralized control panel. The reason? To a great extent, evolution of industrial measurement and control has been a result of industry's constant effort to do more things faster and better—to turn out greater quantities in a given time and still keep the quality at a level considerably above that possible with older, slower methods.

In the development of increasingly complex processing equipment, a point was reached where even the most skilled operator, utilizing manual control, could not possibly keep a close check on the many critical variables. Man was just about to invent himself into a corner. Fortunately, developments in instrumentation kept pace with those in processing equipment and methods so that for every new process or piece of equipment there were instruments for adequate measurement and control.

The modern petroleum refinery serves as an extreme example of another, larger corner. It is a continuous process operated on a large scale, with large processing units scattered over acres of ground. And yet, in spite of widely separated units, each is dependent on the successful operation of adjacent units. The entire process, in turn, depends on correct operation of all components in the system.

Despite size of the processing equipment, it is highly susceptible to fluctuations in variables such as temperatures, pressures, flows, and liquid levels, and demands extremely close control. An upset occurring in a single processing unit is passed on to succeeding ones, and can, unless quickly corrected, upset the operation of the entire process. This may result in greatly decreased production, lowering of product quality, and, in extreme cases, actual damage to processing equipment.

The problem was not one of controlling critical variables; instruments capable of doing this were already available. Rather, it was a problem of making the needed centralized control panel economically feasible, and in a compact form permitting a new operator to be quickly trained to interpret instrument readings in terms of effect on the overall operation of the process.

A typical conventional refinery control panel is shown in Fig. 2. Obviously, size of master control rooms was

rapidly approaching the point where cost was a considerable factor and where they were using much valuable space. Training of new operators was difficult. For although a name plate on each instrument showed its function, a detailed knowledge of the entire process was necessary before an operator could observe a pen movement and quickly comprehend the effect of this single upset on the rest of the process.

And so the graphic panel came into being. Briefly, it achieves two important objectives; (a) condensing the control panel to a size that makes a central control room economically practical, and (b) reproducing the entire process in miniature so that an operator can quickly grasp the relationship between various processing units and flow lines in the entire system.

Fig. 2—Without miniature instruments, control rooms for complicated processes must be large. More operators are needed, and the greater difficulty in learning process functions results in longer training

Semi-Graphic Panels

Two types of graphic panels are in general use. In one, the semi-graphic type illustrated in Fig. 1, control instruments are mounted below and adjacent to the pictorial process flow diagram. Identifying symbols on instrument name plates and identical symbols on the flow diagram, by means of color and shape, show the variable such as temperature, pressure or flow being controlled, and exactly where in the process the control is exercised. Processing equipment and flow lines can either be painted directly on the panel or cut out of some material and mounted.

Another method is the more popular for semi-graphic panels. Key colors on flow lines indicate contents of the piping. Red may mean heating steam; yellow, compressed air; and so on. Quite frequently color shows relative density or condition of material as it is processed. For example, as dilute fluid moves through a process and becomes more concentrated, the flow line will become increasingly darker.

TYPICAL INSTRUMENTATION USED ON GRAPHIC PANELS

Description of Instruments	Single pen	Two pen	One pointer	Two pointers	Multipoint	Pneumatic transmitter	Pneumatic receiver	Electric transmitter	Electric receiver	Temperature	Pressure	Flow	Liquid level	Other variables	Pneumatic control	Electric control	Remote control point setting
Miniature receivers*																	
Strip chart recorder	X	X	...	...	...	...	X	...	...	X	X	X	X	X	...	...	X
Indicator	...	...	X	X	...	...	X	...	...	X	X	X	X	X	...	...	X
Liquid level indicator	...	...	X	...	...	...	X	...	...	...	...	...	X	...	...	...	...
Electronic strip chart recorder	X	...	...	...	...	...	X	...	X	X	X	X	X	...	...	X	X
Valve position indicator	...	...	X	...	...	...	X	...	...	...	...	...	...	...	...	...	...
Circular dial gages	...	...	X	...	...	...	X	...	...	X	X	X	X	X	...	...	...
Miniature recorders**																	
Non-indicating	...	...	...	...	...	X	...	...	...	X	X	X	X	X	...	...	...
Indicating	...	...	X	...	...	X	...	...	...	X	X	X	X	X	...	...	...
Conventional size**																	
Thermometer	X	X	X	X	X	X	X	...	...	X	...	...	...	...	X	X	X
Pressure gage	X	X	X	X	X	X	X	...	...		X	...	X	...	X	X	X
Electronic potentiometer	X	X	X	...	X	X	...	...	...	X	X	X	X	X	X	X	X
Flow meter	X	...	X	...	...	X	X	X	X	...	...	X	X	...	X	X	X
Multiple strip chart recorder	X	...	X	...	X	...	X	...	X	X	X	X	X	X	...	...	...

*Normally mounted in process flow diagram. Often used with non-indicating controller mounted back-of-panel, or near process or control valve.

**Operate in conjunction with indicating or recording receivers and non-indicating controllers. Mounted at or near point of measurement.

***Normally mounted below process flow diagram or in recorder wings flanking graphic panel. In some panels, are mounted directly in process flow diagram.

NOTE: Instruments listed are the basis of graphic panels. Replicas of processing equipment, pumps, heat exchangers, valves, flow lines, etc., are custom engineered for each application. Control accessories such as push button stations, signal lights, and manual valve operating stations are added as necessary.

Only small indicating dial and liquid level gages are mounted directly in the flow diagram of the semi-graphic panel. Conventional recorders are installed either below the flow diagram, or on wings at either end of the panel.

Full Graphic Panels

The second type, the full graphic, is shown in Fig. 3. Miniature recording instruments are mounted directly in the flow diagram. In some cases, miniature indicators are also employed.

To illustrate relationship between instruments and flow diagram, assume the familiar automobile instrument panel is to be converted to a graphic panel. From sheet metal, plastic, or other material, a small profile replica of a battery or a generator would be cut and fastened to the dashboard. The proper indicating dial gage would be mounted in a hole drilled in the center of the replica.

Similarly, the engine heat indicator might be mounted in a replica of the radiator, the fuel gage on a silhouette of the gas tank, and so on. A hasty glance at any of the gages on the panel would pictorially identify the variable being measured.

Similar work has been done experimentally on the many control knobs and levers necessary in the cockpit of today's multi-engined airplane. Shapes of the knobs were made to resemble, insofar as possible, actual plane parts controlled.

Frequently, the miniature valves are equipped with indicators that indicate visually whether they are closed or open, and, if open, just how far. Signal lights on the board can indicate operation of pumps, blowers and other equipment.

Small Instruments Necessary

To make the full graphic panel, Fig. 3, possible, a line of miniature instruments was necessary. For example, the strip chart recorder in the panel has face dimensions of approximately 5 by 5 in. Yet the chart can hold a 30 day record. The recorder also may enable the operator to (a) switch the normally instrument-operated valve to manual control. When used as a straight recorder and no controller is employed with it, it may often be provided with two pens to simultaneously record separate variables, such as temperature and pressure, on a single chart.

When no record of a variable is required, a miniature indicator, performing the same functions except for recording, is used.

Each Panel Different

As might be surmised, every graphic panel is individually engineered to fit needs and preferences of the intended user. For this reason, they vary from small, relatively simple panels including a minimum of indicators and recorders, to very large and complex installations sometimes covering three or four walls of a control room.

Design of a graphic panel begins with careful analysis of the process to be controlled. Where is automatic control desirable, and what type of control will do the best job? Which variables should be recorded, and which merely indicated? How much detail, such as valves, heat exchangers, pumps, and similar auxiliary equipment should be reproduced in miniature and included in the panel?

Once the details are decided, the panel is laid out for greatest operator convenience. It is then fabricated, instruments and control accessories are mounted, and all back of panel piping and wiring are completed. The finished panel is then checked and tested before shipping.

Range of Applications

Although the highly complex control requirements of the petroleum industry were largely responsible for evolution of graphic panels, many other industries are making use of them. For example, chemical plants, wherein one or more continuous processes are made up of a number of interrelated pieces of processing equipment, are finding graphic panels very

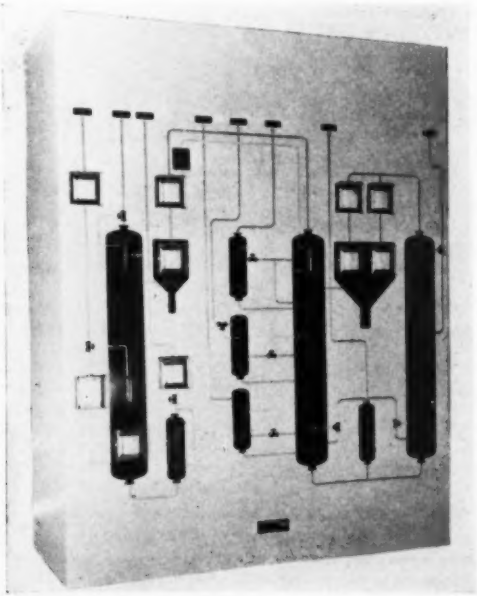


Fig. 3—Full graphic panels have all of the instruments and many controllers mounted directly in the process diagram

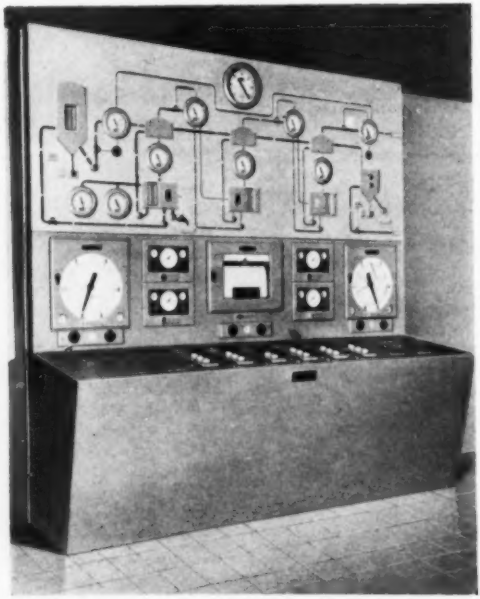


Fig. 4—Operation of paper mill process equipment is shown so concisely that it may be demonstrated to plant visitors

helpful in training of new operators.

In paper mills, where processing equipment is widely separated, and where a single process, such as brown stock washing, may take a space a block long and three or four stories high, graphic panels such as shown in Fig. 4 are proving their worth. They are particularly helpful in cases where the expansion of mill or plant processing facilities will seriously overtax skilled operators, and where training of new operators is an important consideration.

On large industrial or commercial air conditioning installations where it is desirable to be able to quickly check, and when necessary, change temperatures and humidities in a number of conditioned areas, graphic panels fill a real need. A flow diagram can show temperature and humidity of each conditioned area, as well as the location of temperature and humidity sensing elements within the areas. Located in the office of plant engineer or building superintendent, a panel gives pictorial centralized control of the entire system.

It is impossible to draw a clear line of demarcation between applications where a graphic panel should be used and those where it would not be practical. It would, of course, hardly be feasible to employ such a panel to control a couple of batch type retorts or cooking kettles. If, on the other hand, the retorts or vessels are part of a process involving several other processing units, it is quite possible that a graphic panel would add to plant efficiency.

Then there is the plant, such as a dairy or food processing plant, where a great number of visitors are encouraged and a graphic panel could serve two purposes; aiding operators by providing pictorial centralized control, and providing an excellent means of showing visitors the actual flow of materials through the plant.

Each case must be decided on its own merits. The engineer, knowing what he desires to accomplish and being thoroughly familiar with plant and process conditions, can best decide on the type of panel by conferring with an instrument engineer and carefully weighing all of the many factors.

COMPENSATING STRAIN GAGE LEADS

• Errors caused by temperature changes in lead wires of many measuring circuits can often be avoided by using the three wire system common in resistance thermometry. In the case of resistance wire strain gages, particularly in circuits incorporating self-compensating SR-4 strain gages, errors are readily preventable, as pointed out by the Testing Equipment Department of Baldwin-Lima-Hamilton Corporation.

Self-compensating gages eliminate need for "dummy" gages to compensate for temperature changes but render circuits susceptible to error from lead wire temperature changes.

Simplest method is to use lead wires of very low resistance as with copper, or of a low temperature coefficient wire as with constantan or manganin. However, copper wire may require too large a size for convenience, or "dead" resistance of a low-coefficient wire may be too high for practical use.

The so-called three wire system is illustrated in Fig. 1. The upper lead wires are equal and subject to equal temperatures throughout their length. The lower lead wire may differ in resistance and it need not be subject to the same temperatures. This circuit substantially eliminates lead wire errors even with large lead resistance variations from temperature changes.

Fig. 2 shows a convenient way of using the three wire system with a portable strain indicator. In this circuit the third lead wire *f* is in the detector circuit instead of the battery circuit.

When self-compensated gages are used in multiple, a practical arrangement for switching them into the strain indicator is shown by Fig. 3. It is assumed that gages are located sufficiently close together to make temperature effects on the *difference* in lead wire lengths to the several gages negligible. The switch must have a low and constant contact resistance.

The SR-4 20 point switching unit may be used in this way by connecting the *d* leads to any chosen set of *Active gage* terminals (using both terminal screws at each point), tying the correspondingly numbered *Dummy gage* terminals in parallel (again using both terminal screws at each point), and thence to the binding post of the strain indicator.

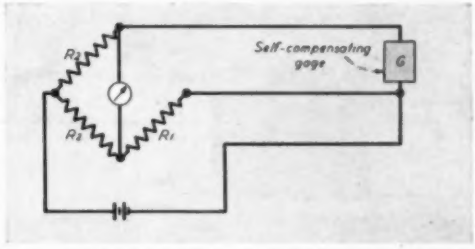


Fig. 1—In three wire system, the potential applied at gage produces equal and opposite R1 drops in upper (gage) leads

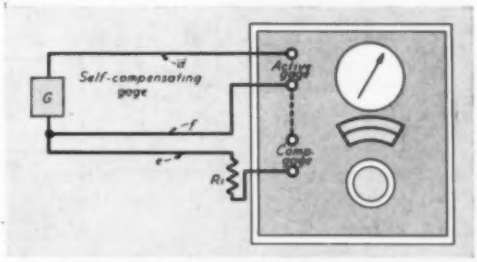


Fig. 2—A strain indicator comprising galvanometer and variable and fixed bridge resistors may be connected as above

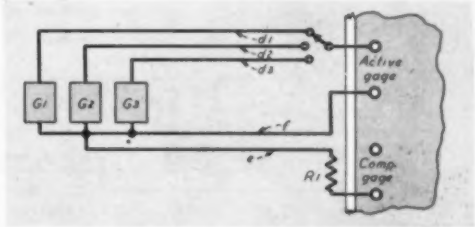


Fig. 3—A number of units with equal original resistance may be checked if all leads d and f are approximately equal

HEAVY FUEL OIL SUPPLY SYSTEMS

Most combustion problems encountered when burning heavy fuel oil can be eliminated by delivering the oil to the burners at the proper pressure, viscosity, and temperature and free from suspended particles that could cause plugging of small burner orifices

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SUCCESSFUL BURNING of heavy industrial fuel oil, exclusive of burners and furnaces, depends on the system used to deliver the fuel oil to the burners. Information concerning methods for handling fuel oil in industrial plants has been somewhat limited, and the main purpose of this article is to present suggestions for improving fuel oil handling systems.

When installing fuel oil storage facilities, several important items must be considered, including the type of carrier that serves the plant site. Most industrial oil is delivered by barge, tank car or truck, and each of these methods requires equipment with specific design features. If the oil is delivered by barge, the transfer pump should have ample capacity to unload rapidly as delays could cause demurrage. Fuel oil

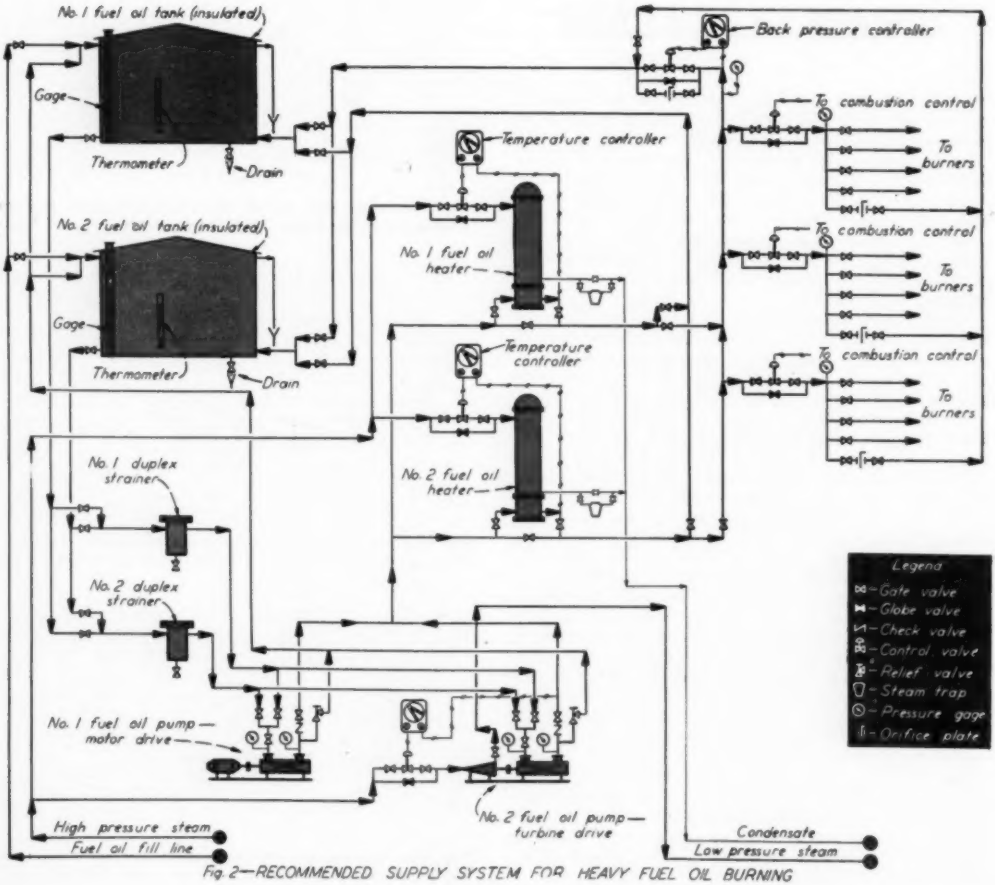


Fig. 2—RECOMMENDED SUPPLY SYSTEM FOR HEAVY FUEL OIL BURNING

received in tank cars must be heated before it can be unloaded, and high pressure steam is required for this service. For truck deliveries, ample space should be provided in the vicinity of the tank so the trucks can move in and out of the plant without delay.

The size of storage tanks will depend on; (a) the quantity of fuel oil consumed, (b) the method of delivery, (c) the size of loads received, and (d) the maximum probable time between deliveries. For barge deliveries, storage tanks will necessarily be larger than for tank car deliveries, while facilities for oil received by truck can be smaller than those employed for tank car loads. Although storage tanks must be placed to accommodate the fuel oil carrier, their location with respect to the point of usage should also be considered when systems are designed. Short suction lines between the storage tanks and the fuel oil pumps that supply the burners generally provide the most convenient arrangement. If suction lines are of necessity long, larger pipe should be used to compensate for the distance.

IMPORTANT COMPONENTS OF FUEL OIL CONDITIONING SYSTEMS

1. Adequate insulated storage tanks located for convenient delivery.
2. Two fuel oil pumps, preferably with both steam and motor drive.
3. Twin strainers for each pump to permit cleaning during operation.
4. Separate suction lines from each pump to each fuel oil storage tank.
5. Automatic controls to maintain constant fuel oil temperature.
6. Adequate fuel oil circulation to insure hot oil to every burner.
7. Controlled viscosity by controlling the oil temperature.
8. Adequate pressure control of fuel oil to the oil control valves.
9. The ability to condition the fuel oil after delivery before using.
10. Proper instrumentation so operating conditions can be observed.

Tank Accessories

All tanks should be equipped with accessories designed to provide reliable service continuity with the minimum maintenance. This equipment includes; (a) filling connections, (b) a vent to the atmosphere, (c) a ladder or stairway to the top of the tank, (d) a top manhole to permit observation of internal conditions, (e) a gage hatch for checking oil level with a pole or chain, (f) a top overflow connection to the sewer or some suitable safe container or pit, (g) separate suction lines for each fuel oil pump, (h) return oil connections, (i) a manhole near the bottom of the tank to expedite manual cleaning if necessary, (j) a water drawoff or drain below the suction lines, (k) insulation to reduce heat losses, (l) tank heaters where circulation is intermittent, (m) indicating or recording gages to show oil level or quantity, and (n) indicating or recording thermometers to show temperature.

Care should be exercised to insure that all tank connections are designed to exclude water or extraneous foreign material. Engineers have found water, burlap bags, sand, newspapers, tumbleweed and other debris in underground storage tanks when answering complaints that fuel oil was unsatisfactory. While this situation does not occur as frequently in exposed tanks, adequate precautions are still desirable.

Twin strainers installed in the suction line of each fuel oil pump will allow cleaning of one strainer while the other is in service. All suction lines from each tank should be valved just prior to the strainers. Strainers with holes or ports slightly smaller than the smallest hole or port in the burners will help prevent or reduce burner plugging, but they should be cleaned on a daily schedule, or oftener for some conditions.

Where a large number of extremely small heavy fuel oil burners are used, installing an oil mill on the discharge of the pump that supplies the burners is often desirable. Oil mills grind up the small particles that pass through the strainer and pump so that the suspended solids are reduced in size and, consequently, there is virtually no chance of plugging up the burners. When oil mills are utilized, the strainers have larger ports to protect the pumps, and the oil mill grinds up the suspended material. In some instances, the strainers are eliminated and individual oil mills are installed for each pump.

An oil mill resembles a centrifugal pump whose impellers have been replaced with a large number of circular saws that rotate in close clearance with stationary saws in the casing. This unit serves two purposes; (a) it grinds up any solid particle to minute size, and (b) it produces a very stable emulsion that does not readily separate out in the storage tank. The main objections to an oil mill are the high first cost and the cost of power to drive the rotor, and its usage is generally limited to applications where; (a) it is economical to use heavy fuel oil, (b) there are a large number of small capacity burners, (c) rather large amounts of solid material in the fuel oil supply forbid use of small port strainers, or (d) fuel oils are to be mixed or blended.

Fuel Oil Pumps

While most fuel oil pumps available are quite satisfactory, many engineers prefer not to use reciprocating pumps because of the difficulty in maintaining constant discharge pressure. As each stroke of the pump causes a surge, air cushion receivers are required to even out the pressure and reduce pulsations in firing. These air cushions are troublesome to keep in satisfactory operation since the air supply must be replenished frequently. Try cocks usually create unsightly area conditions, and gage glasses are almost useless for checking oil level.

Many installations employ centrifugal, positive displacement eccentric rotor, or gear type pumps with either electric motor or steam turbine drive. Most motor driven units operate at constant speed and no controls are necessary. For turbine drives, the preferred method of control is to utilize a constant pressure regulator for modulating steam flow thereby controlling turbine speed to produce constant fuel oil pressure at the pump discharge. Another means of controlling pump speed is the mechanical turbine speed governor, which in many cases is satisfactory. However, all turbines should be equipped with an overspeed trip.

Relief Valves

Constant oil pressure is a must and cannot be over emphasized, but in addition to the operating controls, relief valves must be installed on the discharge of the pump. These valves should be connected to piping that will convey the released oil to the top of storage tanks or to some suitable point in the suction line. This piping should not be equipped with valves and if used, they should be padlocked in the open position. When repairing a relief valve, the pump starting equipment must be locked.

The sizing of fuel oil pumps is quite important and is frequently overlooked. A good rule to follow in sizing a pump is to calculate the maximum fuel oil consumption and then double this quantity. This will allow for circulating as much fuel oil back to the storage tank as is being burned, allow for wear of the pump, and provide means of conditioning a tank of colder fresh oil for burning later. Maximum temperature should also be considered as in some types of pumps, high oil temperatures reduce the clearances to the extent that the pump will seize and stop. Of course,

the pump must be designed for the maximum pressure that will be encountered even when protected by a relief valve on the discharge.

Fuel Oil Heaters

For the average industrial application, a fuel oil temperature of approximately 200 F is required at the burners. Electric heaters are sometimes used for this service, but normally they cause too high an operating expense. The majority of installations utilize shell and tube exchangers with low pressure or exhaust steam as the heating medium. These exchangers have removable heads so the inside of the tubes can be cleaned or, if necessary, the entire tube bundle removed for repair or replacement. For all methods of preheating, automatic oil temperature control is recommended to maintain constant firing conditions. In addition, control is essential for keeping exchangers clean as excessive temperature may cause fouling.

Some storage tanks include internal steam coils to condition the oil before it is circulated through the suction lines. These coils should have welded elements, especially when using high pressure steam, as any leaks that develop will allow condensate to enter the fuel oil. Similar precautions should be taken for heaters located in suction lines or inside the storage tank near the suction connection for the oil pumps.

When a leak occurs in an external exchanger, the oil will leak into the steam side and be discharged by the steam trap since the steam pressure is normally less than the oil pressure. This arrangement prevents water contamination of the fuel oil, and heat exchanger oil leaks can be readily observed by examining the discharge from the steam trap. However, a leaking steam coil enclosed in the tank may contaminate all of the oil before the leak is discovered. Further complications might result if the steam supply was uncontrolled as excessive temperature could cause the tank to boil over.

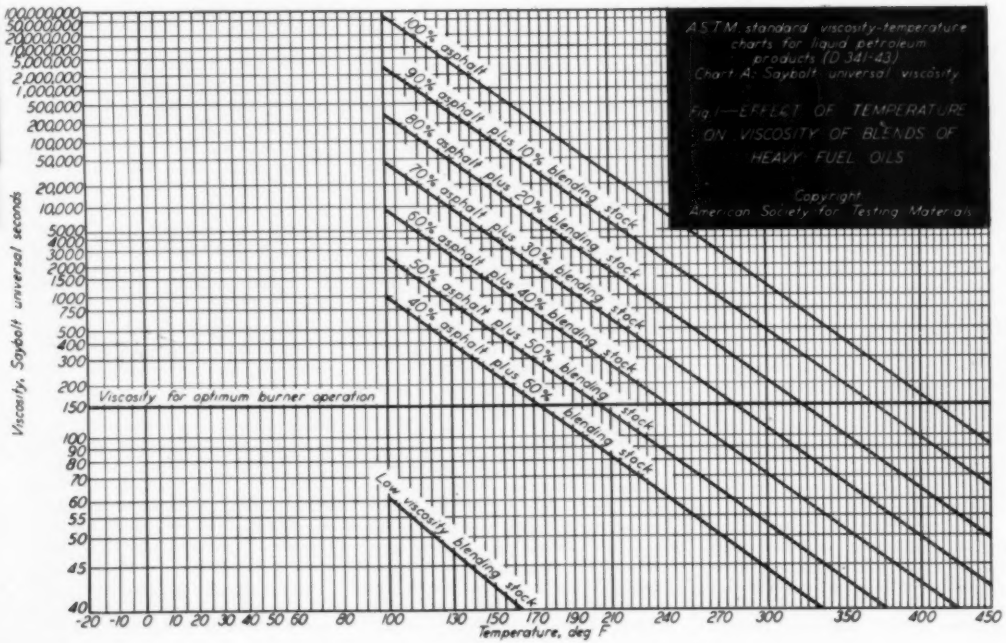
Importance of Viscosity

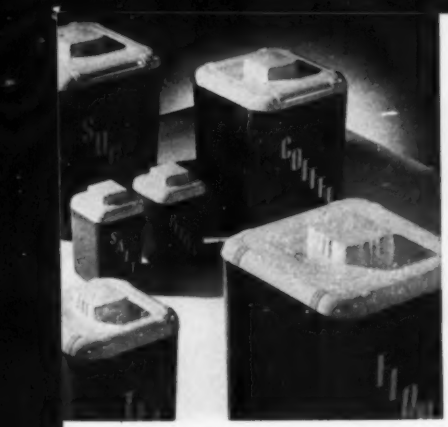
Viscosity control of the oil to the burners is extremely important, particularly for high pressure mechanically atomized systems. When fuel oil temperature increases, viscosity decreases, and vice versa, so any desired viscosity can be obtained by changing the temperature. It is possible to have the same viscosity of Bunker "C" fuel oil as for domestic fuel oil by merely increasing the temperature of the Bunker "C". The accepted viscosity for satisfactory heavy fuel oil burning is that viscosity which would be equivalent to 150-155 Saybolt universal seconds at 100 F. If the fuel oil is free of sediment and viscosity is the same, the burners will not recognize the difference between Bunker "C" and distillate fuel oil. Fig. 1 illustrates the effect of temperature on viscosity of various fuel oil blends.

Industrial systems should be designed to handle the heaviest fuel oil available to take advantage of the higher Btu per gal content. It is not the kind of oil that is important but how the oil that is available is conditioned before burning. Fig. 2. illustrates one suggested arrangement for an average heavy industrial fuel oil system designed to provide satisfactory results. No oil mill has been included as it serves only special limited applications.

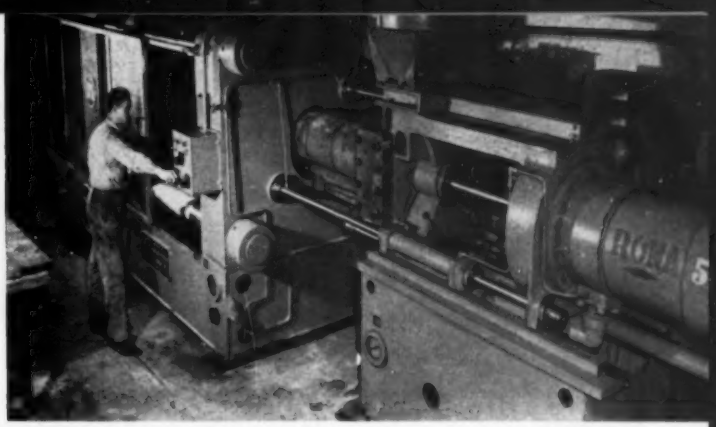
While the items discussed here may appear elementary, they are essential to successful heavy fuel oil burning. If fuel oil is heated, circulated and properly conditioned before burning, there will be less trouble with pumping, fouling of exchangers, sedimentation in tanks, and equipment outages. There are numerous problems incident to good fuel oil burning, such as burners, furnace shape, furnace volume, air temperature, refractories, waterwall cooling and many others, but these problems will be minimized if the fuel oil is at all times delivered to the burners free of sediment and water and at the right temperature, pressure and viscosity.

This article was abstracted from a paper presented by the author at the Combustion Conference held by the College of Engineering of the University of Michigan in March, 1951.


A.S.T.M. standard viscosity-temperature charts for liquid petroleum products (D 341-43)
Chart A: Saybolt universal viscosity
Fig. 1—EFFECT OF TEMPERATURE ON VISCOSITY OF BLENDS OF HEAVY FUEL OILS
Copyright American Society for Testing Materials
100% asphalt
90% asphalt plus 10% blending stock
80% asphalt plus 20% blending stock
70% asphalt plus 30% blending stock
60% asphalt plus 40% blending stock
50% asphalt plus 50% blending stock
40% asphalt plus 60% blending stock
Viscosity for optimum burner operation
Low viscosity blending stock
Viscosity, Saybolt universal seconds
Temperature, deg F



NO MORE PROBLEMS. The production of plastic household items by Rona Plastic Corporation was slowed down by an inadequate hydraulic oil. A switch to Sunvis 999, over a year ago, restored it to normal.



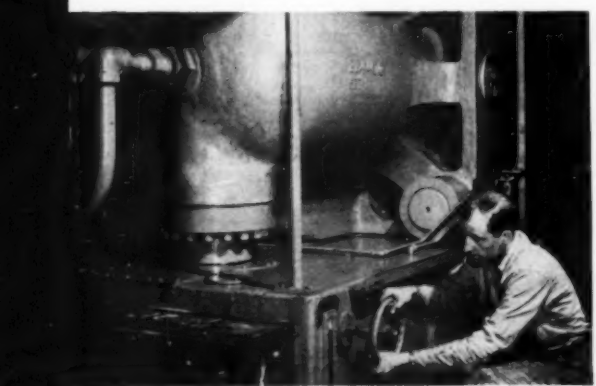
PRESSURE LOSSES ENDED. There are few plastic molding machines as big as this 60 ounce model. It exerts a pressure of 1,000 tons. Because the hydraulic oil formerly used sludged up and thinned out, it could not maintain this pressure. But Sunvis 999 has fully met these severe requirements, as well as those of Rona's nine other hydraulic machines of varying sizes.

PLASTIC MOLDER'S BOTTLENECK ENDED BY SUNVIS HYDRAULIC OIL

More than a year ago Rona Plastic Corporation, New York City, had trouble with its hydraulic molding machines. The machines functioned erratically due to oil sludge sticking the control mechanisms. In addition, the oil thinned out excessively at normal operating temperatures, and resulted in the loss of proper clamping pressures on the dies. To keep the machines going at all, it was necessary to drain, clean, and entirely recharge the systems at frequent intervals.

A Sun representative, called in by Rona, studied the problem and recommended Sunvis 999. He knew it would put an end to pressure losses, because, even at elevated temperatures, it does not decrease in viscosity as much as most other oils. He also knew its exceptional stability would end the sludging problem.

Sunvis 999 proved to be the answer to all Rona's hydraulic oil problems. The original charges, with minimum make-up, are still giving good service. Rona can expect the same performance for a long time to come, because experience shows that under normal operating conditions, Sunvis 900 Series Oils are *good for the life of the equipment.*



NO OIL CHANGES HAVE BEEN NEEDED. Before Sunvis 999 was adopted, the oil in each of the machines had to be changed frequently (the one pictured holds 450 gallons). The original charges of Sunvis 999 have been in use now for more than a year.

Department IP-8
Sun Oil Company, Philadelphia 3, Pa.

I am interested in knowing more about Sun Hydraulic Oils. ☐ I would like to consult with a Sun representative. ☐ Send the booklet "Hydraulic Fundamentals and Industrial Hydraulic Oils."

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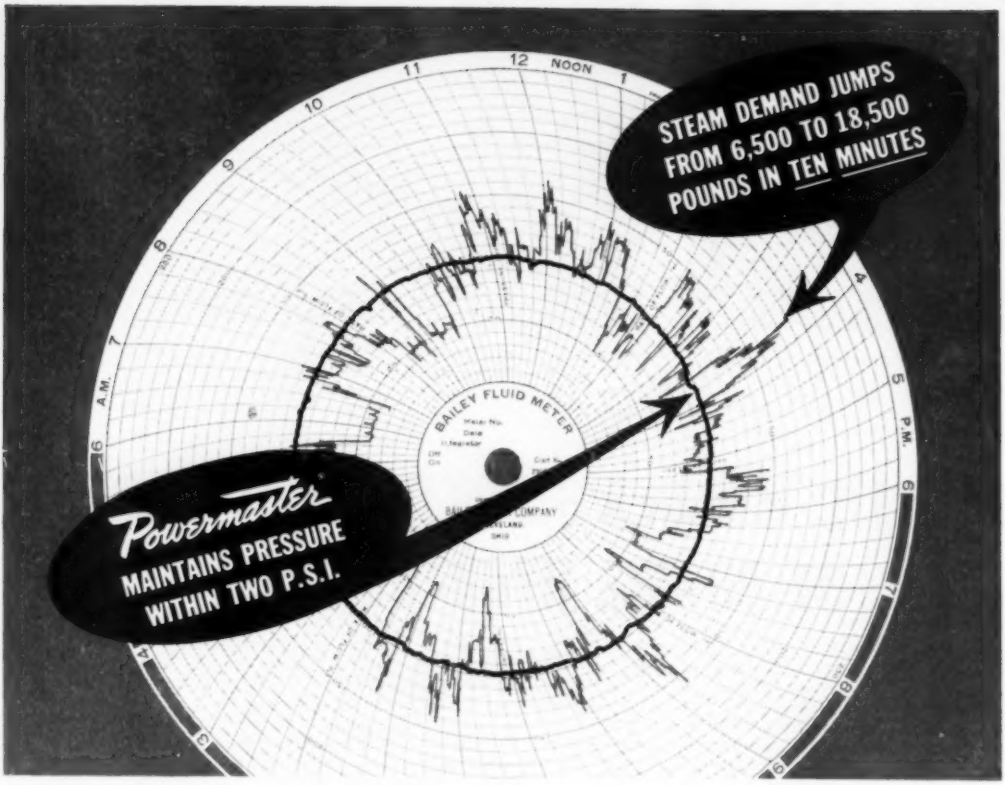
TECHNICAL ASSISTANCE AVAILABLE. Sun's engineers are at your service for consultation on all hydraulic oil applications. It will pay you to utilize the experience they have gained in solving a wide variety of problems in many different industries.

SUN INDUSTRIAL PRODUCTS

SUN OIL COMPANY, PHILADELPHIA 3, PA. • SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

SUNOCO®



Performance records prove *Powermaster's* VORIFLOW combustion responds immediately to steam demand . . . and at full efficiency

At a large southern cotton mill, two 300 h.p. POWERMASTER boilers are generating steam 'round-the-clock at a constant pressure of 100 p.s.i. Note how evenly this pressure (blue line on chart) was maintained even though steam demand (red line) varied from a low of 3,000 pounds per hour to a high of more than 18,500. Between 3:30 P.M. and 3:40 P.M. the load nearly tripled . . . but the POWERMASTERS responded immediately with insignificant pressure change and no "hunting".

This kind of performance is possible because of POWERMASTER's exclusive VORIFLOW combustion. Here's what it will do for you:

1. Saves fuel by providing infinitely variable combustion modulation in response to demand—with *full efficiency*—through wide range from 30% to 100% of firing capacity.

This means elimination of waste and maintenance headaches because of incomplete combustion. The VORIFLOW air-atomizing oil burner does away with outmoded mechanical spinning devices, globules of wasted oil, and gummy cleaning problems. The VORIFLOW gas burner is an O&S pre-mix design equally efficient at all firing rates between 30% and 100% loads.

2. Slashes boiler maintenance costs.

The burner has *no* moving parts to wear out • There is *no* cup to clean daily • Routine cleaning of the burner once a month is sufficient • There is *no* burner vibration to throw adjustments "out of whack" • Parts are made of stainless steel, brass, and beryllium copper—they will last indefinitely.

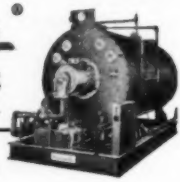
3. The combination burner permits rapid change-over from one fuel to another—light oil, heavy oil, or gas.

Before deciding on a boiler for your plant, be sure to get the facts on the newest POWERMASTER with VORIFLOW combustion. Write for this catalog that gives you the entire story of the *Powermaster* packaged automatic boiler. Just drop us a line and we'll put one in the mail for you.

Powermaster®

PACKAGED AUTOMATIC BOILERS

In sizes to 500 HP; pressures to 250 psi.



ORR & SEMBOWER, INC. • Established 1885 • **950 Morgantown Road, Reading, Pennsylvania**

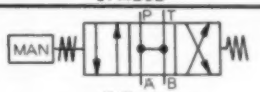
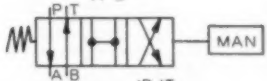
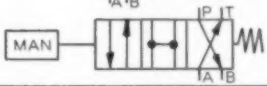
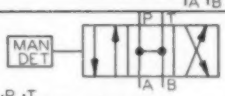
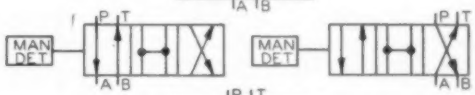
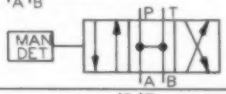
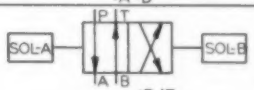
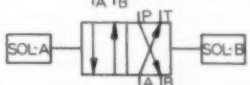
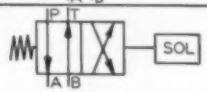
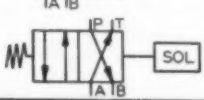
Handbook for engineered plant services

Methods, data and ideas that make excellent references in solving engineering problems frequently encountered in plant operations

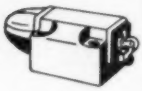
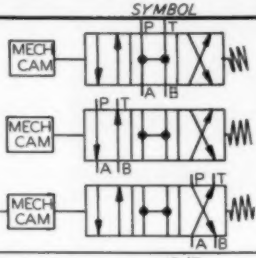
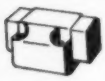
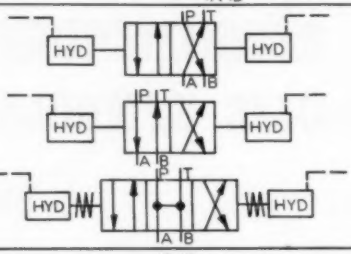
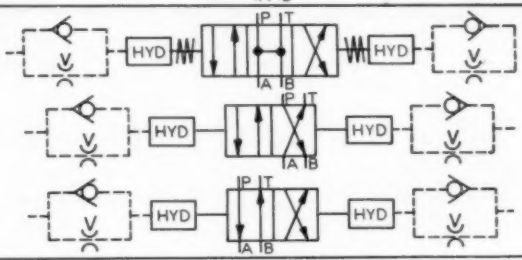
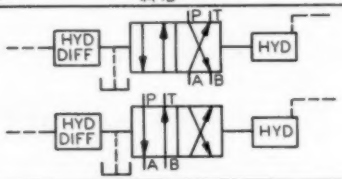
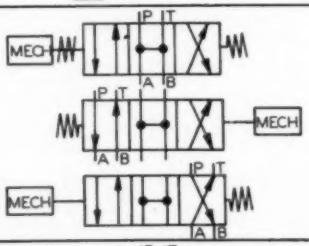
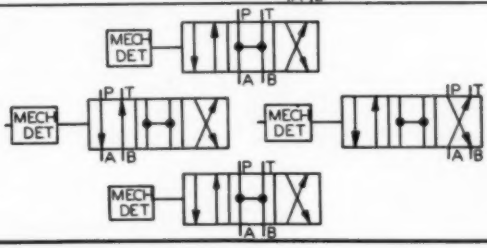
RECOMMENDED HYDRAULIC SYMBOLS

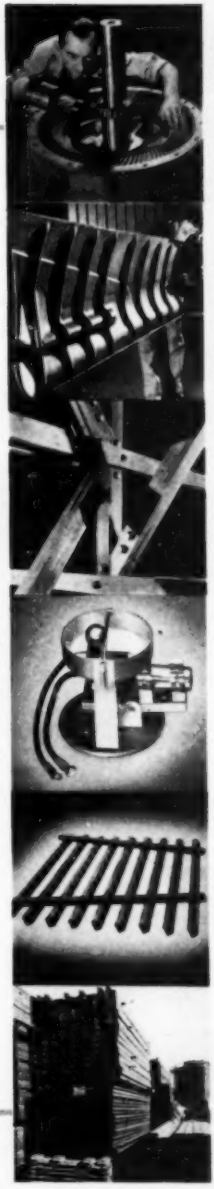
Hydraulic symbols in this article and following issues will aid the engineers responsible for engineered plant services in setting up an adequate program in the plant. These data have been suggested and approved by the Joint Industrial Conference. Their usage will coordinate your work.
Courtesy of the Denison Engineering Co.

OPERATING 1/4 INCH 4-WAY VALVES (Note: open center spool shown in all valve diagrams)

PRODUCT	CHARACTISTIC	POSITION	SYMBOL
Manually operated	*Spring positioned 3 Positions 4 Connections*	*Spring centered*	
		Spring offset to A	
		Spring offset to B	
	Detent positioned 3 positions 4 connections	*3 detents 3 positions*	
		2 detents position A or B	
		1 detent center position	
Double solenoid operated	*No springs 2 positions 4 connections*	*Solenoid A energized*	
		Solenoid B energized	
	Spring centered 3 positions 4 connections	*Spring centered*	
Single solenoid operated	*Spring offset 2 positions 4 connections*	*Solenoid de-energized*	
		Solenoid energized	

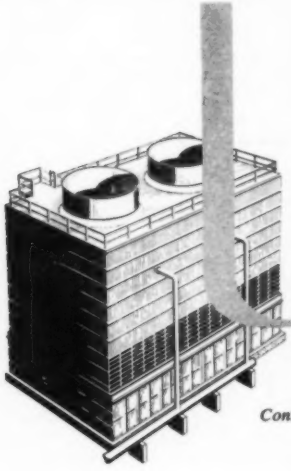
OPERATING 1/4 INCH 4-WAY VALVES (Note: open center spool shown in all valve diagrams)

PRODUCT	CHARACTISTIC	POSITION	SYMBOL
 Cam operated	Spring offset 3 positions 4 connections	Center position Depressed Spring offset	
 Pilot operated Plain end caps	No springs 2 positions 4 connections Spring centered 3 positions 4 connections	Pilot pressure to right hand connection Pilot pressure to left hand connection Spring centered	
Pilot operated With throttle end caps	Spring centered 3 positions 4 connections No springs 2 positions 4 connections	Spring centered Pilot pressure to right hand connection Pilot pressure to left hand connection	
Pilot operated With diff. end cap	No springs 2 positions 4 connections	Pilot pressure to right hand and left hand connections Pilot pressure to left hand connection	
Stem operated Mechanical	Spring positioned 3 positions 4 connections	Spring centered Spring offset in Spring offset out	
	Detent positioned 3 positions 4 connections	3 detents 3 position 2 detent positions in or out 1 detent center position	



ONLY FLUOR

induced draft counterflo cooling towers provide these 6 exclusive features...



Spiral Bevel Gear Speed Reducers

Only Fluor-Western speed reducers incorporate curved tooth spiral bevel gears as standard design. This proven principle provides quieter, smoother, more efficient operation under the rugged conditions of cooling tower service. Other special design features include: oil-bath lubrication; dry air breather; chrome-plated shaft at oil seals; and, low-speed fan shaft mounted on special steep angle thrust and radial bearings to take combined gear thrust, fan thrust, and weight of fan assembly.

Unique Fan Blade Design

The Fluor Type HC Stainless Steel Fan blades, furnished as standard on every Fluor Counterflo Cooling Tower, are a joint development of The Fluor Corporation and Solar Aircraft Company. Designed specifically for induced draft cooling tower service, their unique air foil handles maximum air volumes at minimum tip speeds and horsepower requirements. Design *plus* mechanical arrangement eliminates recirculation of air and resulting power-consuming turbulence.

Internal Gusset Plate Construction

Fluor Counterflo Cooling Towers alone make full use of tensile as well as compressive strength of structural members! Their internal gusset plate design duplicates that used in wooden bridge construction. These simple, yet extremely strong joint connectors mean longer tower life, lower total tower weight, fewer and simpler castings, greater ease of erection, and minimum spoilage should the structure be dismantled, moved and re-erected.

Patented Vibration Cut-Out Switch

The Vibration Cut-Out Switch developed and patented by Fluor in 1944 protects tower structure and mechanical equipment by stopping the motor should excessive vibration suddenly occur. In addition to its value as an emergency safety device, the switch can be utilized by the operator as a positive "on-off" switch during routine inspection of tower structure and mechanical equipment. The motor cannot be started accidentally once the switch is placed in the "off" position.

Sloping-Bar Grid Decking

Exclusive Fluor-designed sloping-bar grid decks are of rough-finished 1" select redwood machine-nailed to 1" x 2" cleats—strong enough for use as scaffolding during erection, rugged enough to withstand the erosion of falling water. This means low maintenance and replacement cost. The sloping-bar design and arrangement of each deck cross member combines the advantages of maximum deck surface with minimum air pressure drop through tower.

Complete Prefabrication of Structure

Only Fluor Counterflo Cooling Towers are completely prefabricated. This offers many advantages to the operator. Tower parts are "packaged" for rapid delivery, marked for orderly erection. Erection is faster, easier, at lower cost. All cutting, drilling and nailing is completed at the factory. Prefabrication means standardization—low-cost replacement of standard parts that may become damaged over the years. It means uniformity in both performance and appearance.

Contact your nearest Fluor representative for detailed information. You Can Be Sure With Fluor

FLUOR

Engineers - Constructors - Manufacturers

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Spot news

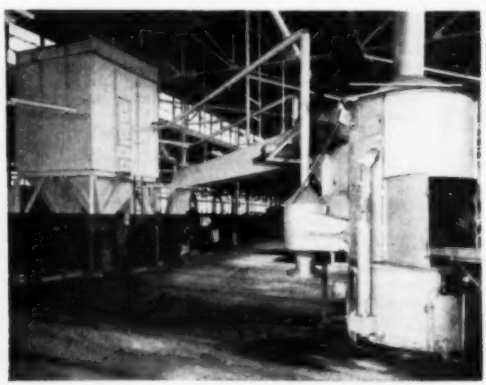
Short, "boiled-down" paragraphs on the most interesting recent events and developments in American industrial plants

Dust Collection Equipment Eliminates Lead Oxide Dust and Fume in Storage Battery Plant

Lead oxide dust and fume have ceased to be problems for Willard Storage Battery Co. All battery manufacturing operations in four of their plants are ventilated by carefully designed hoods which collect dusty air and pass it through cloth-type dust collectors manufactured by American Wheelabrator & Equipment Corp.

One typical installation is at their Memphis, Tenn. plant, where one collector with a cloth area of 2115 sq ft handles all air required to ventilate a battery plate cutting machine, a conveyer housing, and a refining kettle. When plates are cut on the machine, the scrap falls into a pit under the floor and is conveyed to a refining kettle to be melted for re-use. Air passing through the hoods and pit is kept at high velocity in order to collect all dust generated at the plate cutting machine. The conveyer is totally enclosed and ventilated by ducts. An attached hood, for dross collection at the refining kettle, traps lead oxide fumes. A hood on the conveyer discharge also ventilates the kettle.

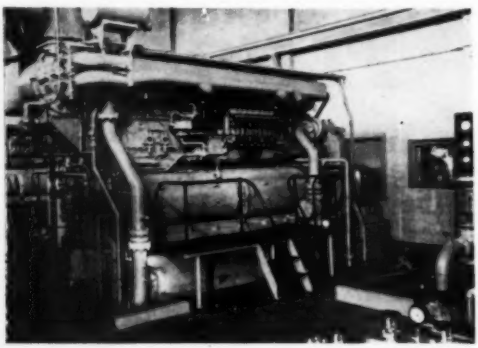
The cloth in the Memphis installation is in the form of cotton sateen tubes, selected after a thorough study of conditions. At predetermined intervals these tubes are mechanically shaken to dislodge the collected dust, which then falls into a hopper. Each hopper is equipped with a swing gate valve which swings downward to empty the contents into standard lead oxide cans. One end of a tight canvas tube is clamped to the hopper and the other end is fastened to a special lid on the cans to prevent dust from escaping into the atmosphere during emptying operations.



Refining kettle showing hood around conveyor discharge and attached hood for dross collection. Collector is visible in background. Stack atop kettle exhausts combustion gases

Pipeline Transports Alberta Oil Across the Border to Superior

First to carry Alberta oil across the border of Canada and the United States, the Interprovincial-Lakehead pipeline was placed in operation in the winter of 1950-51. This 1137 mile pipeline transports crude oil to Superior, Wis. for subsequent shipment by tanker to refineries in eastern Ontario. Not only is the whole system unusual for the international agreements worked out, but the equipment used on both sides of the border is identical.



Nine stations in Canada and two in this country, with a third under construction, now serve the pipeline. All are similar, except for size and number of pumping units employed. Each is equipped with either 2, 3 or 4 pumping units connected in series. The engines are either 6 or 8 cylinder, 12½ x 13 in., dual-fuel or straight diesel type. In the United States these units were built by American Locomotive Co. For Canadian stations, Dominion Engineering Works supplied units of the same design under a licensing agreement. Crude oil brought into a settling tank from the pipeline is pumped to centrifuges and then through filters to the engine day tanks, thus setting up a continuous system for fuel.

The diesel engines drive centrifugal pumps through step-up gears having a ratio of approximately 6:1. The main line pumps were furnished in Canada by the Canadian manufacturing concern licensed to build pumps of Byron-Jackson design, while those in the United States were furnished by the Bingham Pump Co.

Since the stations are situated in isolated locations and operate at temperatures ranging from -50 to 90 F, each employs a single building protected by fire walls and other devices. An interior view of the Edmonton, Alberta station is shown in the illustration. One of the centrifugal pumps is visible through the observation window of the fire wall.

B&W Develops Oil Additive To Relieve Boiler Slagging

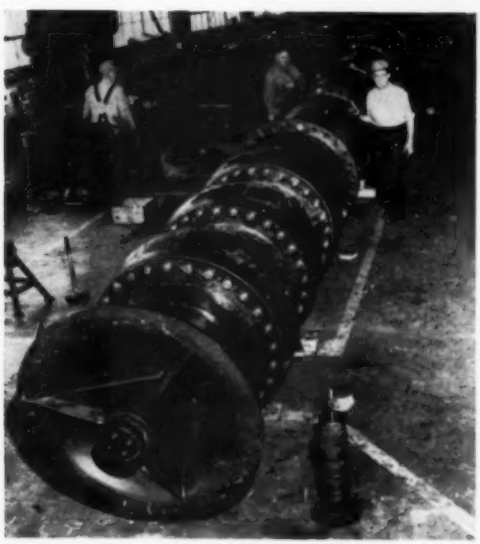
Significant results in relieving the problem of deposits on boiler tubes resulting from the firing of residual fuel oil have been reported by The Babcock & Wilcox Co. Certain grades of oil such as Bunker C have long been recognized as having the disadvantage of depositing a hard residue on boiler heat transfer surfaces, particularly superheater tubes. Frequent interruptions in operation are required for cleaning, since the deposits are not readily removed by air or water lancing.

Investigations begun at the B&W Research & Development Center in Alliance, Ohio in 1949, found that the deposits were characterized by low-melting constituents. Laboratory work was therefore carried out on selected materials which would raise the melting point so that the ash would be dry upon deposition.

Field tests were later carried out in several stations of the Florida Power Corp. using alumina and dolemite as the additives. Both resulted in a fine powdery deposit instead of the usual hard, glassy, fused material. Tests indicated that by using the additive, boiler surfaces can be kept clean for an indefinite period with only the use of a 200 psi air lance every five to seven days.

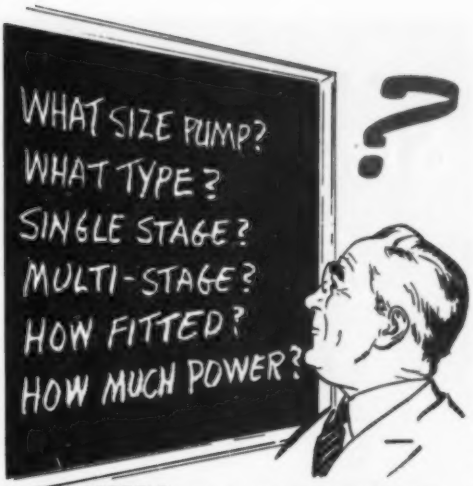
In general, the field tests with additives have indicated that it is commercially feasible to operate and to effect a real saving in labor required to keep a unit operably clean and operating efficiently with present day oil fuel. In addition, the corrosive quality of the stack gases is greatly reduced and the nuisance from flyash particles is not as great.

—End



AIR FORCE INSTALLS WORLD'S LARGEST WELL PUMPS

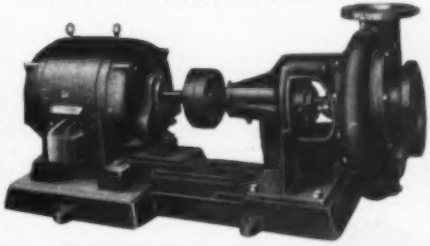
Four deep well turbine pumps, the largest ever built, are being installed by the USAF at its rocket research base, Tullahoma, Tenn. Contrasted against one of the units is an ordinary 6 in. turbine pump shown in the foreground. Produced by Fairbanks, Morse & Co., each of the 48 in., 25,000 gpm units is 42 ft long, weighs 30,000 lb and is driven by a 2000 hp motor



IF PUMPS ARE YOUR PROBLEM, CALL IN A WEINMAN SPECIALIST...

Selection of the right pump to handle a specific liquid handling problem, calls for skilled judgment backed by years of experience. That's why thousands of pump users have put their pump selection problems in the hands of a Weinman centrifugal pump specialist. For more than 50 years these Weinman specialists have helped pump users in every type of industry, and with every kind of liquid handling problem to get the results they wanted to put their pumping operations on a paying basis.

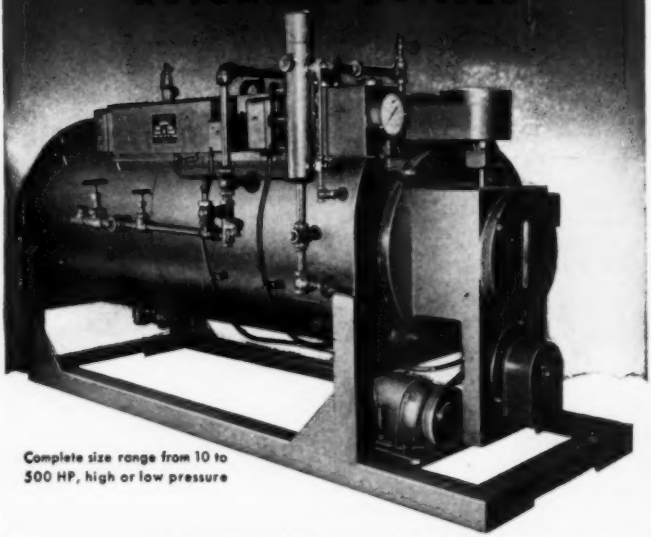
Basic design, precision manufacture and progressive research make Weinman centrifugal pumps first choice for low initial cost, year-round operating efficiency and virtually maintenance-free service. So, take your fluid handling problems to a specialist —your nearby Weinman representative, who KNOWS pumps. Write, wire or phone for his recommendations . . . TODAY.



Representatives in principal cities

WEINMAN

Steam at low cost
Continental



Complete size range from 10 to 500 HP, high or low pressure

Savings you make with a Continental Packaged Automatic Boiler rapidly repay your initial investment. First, you save on installation. The unit is factory assembled and tested, ready to operate after simple service connections in your plant. Second, you save on fuel. The Continental operates with guaranteed efficiency of at least 80%. Independent tests prove the steam generated contains less than 1% moisture.

Of proven design, this boiler requires no furnace refractory. The fuel is burned in a furnace entirely surrounded by water, and the gases pass spirally through the tubes, giving maximum heat transfer, low flue gas temperature, and high efficiency.

Third, you save on maintenance. Replacement of cracked refractory is eliminated and boiler front and back can be opened in 15-20 minutes, simplifying cleaning and servicing. Many users report these and other major savings with the Continental in heating and processing.

The unit is completely automatic and equipped with efficient burners for heavy oil, light oil, gas, or a combination. May we send you literature that fully describes it?

BE

DISTRIBUTORS—PLEASE NOTE: A few choice territories are open. Request details on your company letterhead.

News
of men and companies

SOCIETIES

The American Society of Mechanical Engineers—F. S. Blackall, Jr., president and treasurer of the Taft-Pierce Mfg. Co., is nominated 1953 president.

Stoker Manufacturers Association—Elects the following officers for the ensuing year: President, LeRoy C. Dubs, Canton Stoker Corp.; Vice-president, B. O. Fink, Auburn Foundry, Inc.; Secy-Treasurer, H. B. Scoville, Cotta Transmission Co.

ANNOUNCEMENTS

Blaw-Knox Co.—Combines its Power Piping and Sprinkler Divisions and names D. A. Black mgr of the div.

U. S. Hoffman Machinery Corp.—Elects G. E. Bowdoin to president, succeeding A. C. Bruce who becomes chairman of the board, following the resignation of L. J. Belnap. Mr. Belnap will continue as a director.

G. E. Bowdoin J. A. Messenger

Buell Engineering Co.—J. A. Messenger, v-p, genl mgr and director, retired July 1 to take up consulting engineering activities at 7826 Eastern Ave., Philadelphia, Pa.

NEW REPRESENTATIVES

Edward Valves, Inc.—Appoints Reed & King, Inc., Foshay Tower, Minneapolis, Minn. sales representative for Minnesota, North Dakota, South Dakota and Northwestern Wisconsin.

Owens-Illinois Glass Co.—The Homestead Insulation Co., 45 Granby St., Hartford, Conn. is named distributor-applicator for Kaylo insulation.

SALES OFFICES

Babcock & Wilcox Co.—D. W. Jones, Jr., sales representative for the Tubular Products Div., opens new offices in the Goby Bldg., 1321 Bannock St., Denver.

I-T-E Circuit Breaker Co.—Establishes a new district office at 722 East Washington Blvd., Los Angeles. W.

R. L'Hommedieu, who has been the company's representative at the same address, is now district mgr.

Quaker Rubber Corp.—This division of H. K. Porter Co., Inc., opens a new stock-carrying branch warehouse and sales office at 1327 Levee Street, Dallas.

APPOINTMENTS

Allis-Chalmers Manufacturing Co.—R. S. Stevenson is now executive v-p. W. G. Scholl succeeds Stevenson as v-p in charge of the tractor div. Named to succeed Scholl as v-p and genl sales-mgr is F. Mussell.

Alloy Steel Products Co.—E. J. Lickwar replaces H. V. Evans, Jr., as sales representative in the Pittsburgh area.

The Fluor Corp., Ltd.—J. McKay is promoted to mgr of sales promotion.

General Electric Co.,—Appoints J. F. Fyock district representative in the Construction Materials Division's northeastern district. His office is at 535 Washington St., Buffalo.

Jenkins Bros.—H. H. Jaynes succeeds A. D. Weber, retired, as New England manager.

Magnatran, Inc.—C. T. Bannwert is appointed in charge of distributor sales.

Republic Rubber Div., Lee Rubber & Tire Corp.—R. B. Benson, P. D. O'Neill and S. P. Terlecky are promoted to field engineers.

Research Corp.— Names S. E. Specht executive sales engineer.

Toledo Pipe Threading Machine Co.—H. F. McClellan is made representative in the territory including Delaware, Maryland, New Jersey, Pennsylvania, Virginia and Washington, D. C. He will make his hqtrs in Philadelphia.

Worthington Corp.—M. E. Ziegenhagen becomes advertising and sales promotion mgr. F. E. Peltier is named mgr of central regional engineering and service, with offices in Cleveland. Four promotions in the Buffalo plant are as follows: H. W. Whiting is now asst to the executive engineer; W. A. Scheerer is promoted to chief engineer—Compressor Div.; W. J. Blessing is appointed consulting engineer; W. M. Kauffmann is named chief engineer—Engine Div.

Link-Belt Co.—R. W. Suman is appointed chief engineer for the new Col-

R. W. Suman **N. Virkler**

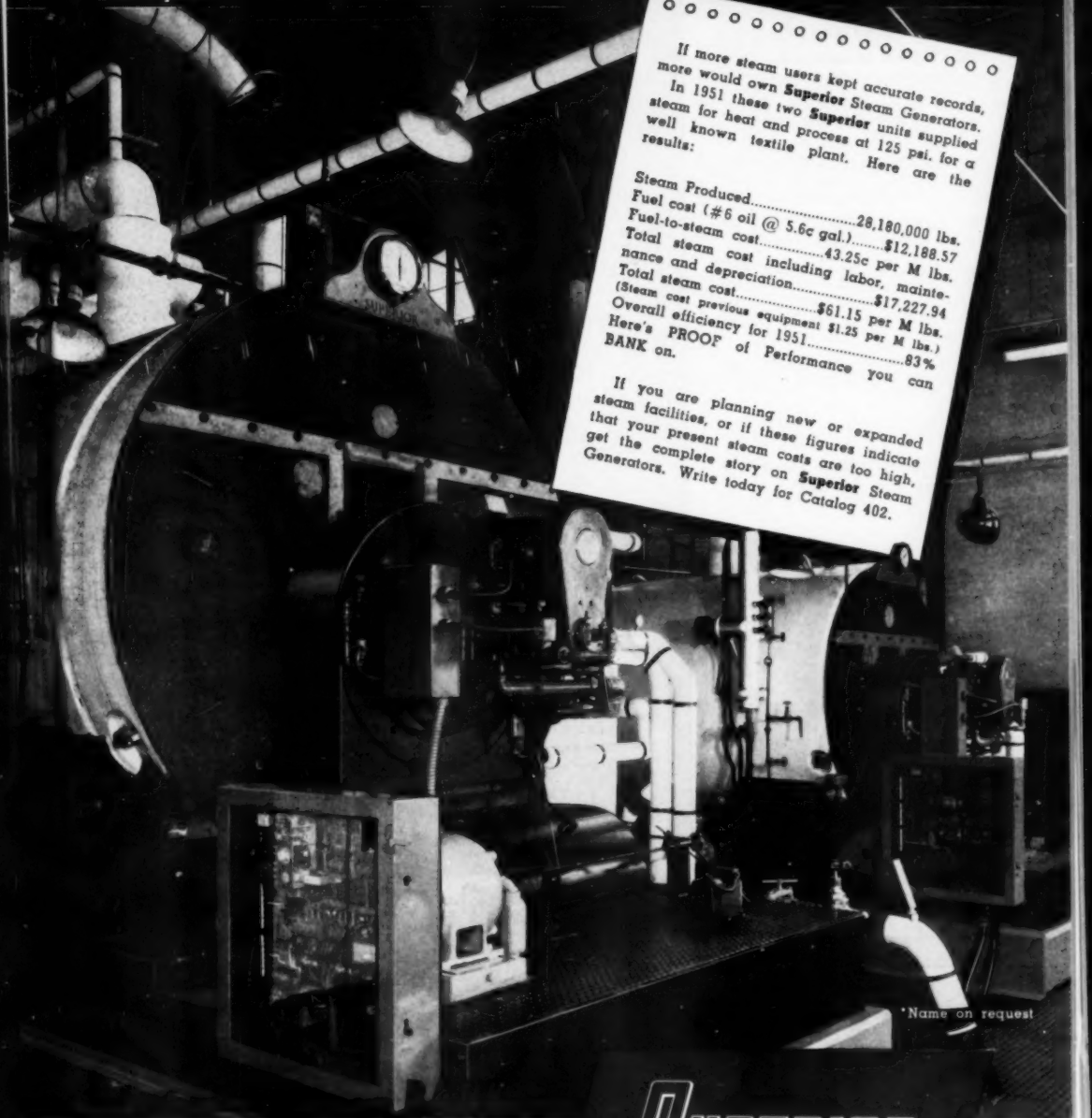
mar, Pa., plant. N. Virkler succeeds Suman as chief engineer for the Philadelphia plant.

HOFFMAN
PRESSURE REDUCING VALVES
TEMPERATURE REGULATOR
HOFFMAN
HOFFMAN TRAPS VALVES PUMPS
HOFFMAN SPECIALTY MFG. CORP., 1001 YORK ST. INDIANAPOLIS 7, IND.
Makers of Valves, Traps, Vacuum and Condensation Pumps, Forced Hot Water Heating Systems.
Sold by leading wholesalers of Heating and Plumbing Equipment.

accept no estimate of economy

LOOK at these actual STEAM COSTS

from a prominent Rhode Island Textile Manufacturer *



If more steam users kept accurate records, more would own **Superior** Steam Generators. In 1951 these two **Superior** units supplied steam for heat and process at 125 psi. for a well known textile plant. Here are the results:

Steam Produced.....28,180,000 lbs.
Fuel cost (#6 oil @ 5.6c gal.).....$12,188.57
Fuel-to-steam cost.....43.25c per M lbs.
Total steam cost including labor, maintenance and depreciation.....$17,227.94
Total steam cost.....$61.15 per M lbs.
(Steam cost previous equipment $1.25 per M lbs.)
Overall efficiency for 1951.....83%

Here's PROOF of Performance you can BANK on.

If you are planning new or expanded steam facilities, or if these figures indicate that your present steam costs are too high, get the complete story on **Superior** Steam Generators. Write today for Catalog 402.

*Name on request

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

SUPERIOR
STEAM GENERATORS

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

1. NEW EQUIPMENT

Begins on page 8

Contains highlights of new products by leading manufacturers, briefed and illustrated for your easy reference. Complete data on each of these products are available ***free.***

2. NEW BULLETINS

Begins on page 130

Includes descriptions of only those bulletins and catalogs that are really ***new*** and of ***direct value*** to you — saves your reading time, yet gives you full service. All bulletins sent to you ***free*** on request.

3. READERS GUIDE TO ADVERTISED PRODUCTS

Begins on page 117

Designed to catalog advertised products for your convenience in finding the ads which are of special interest to you at this time. Also lists those important bulletins, catalogs and working data offered ***free*** in the advertisements.

REQUEST CARD FOR LITERATURE OR MORE INFORMATION—Aug., 1952

To: INDUSTRY AND POWER, St. Joseph, Mich. Please have forwarded to me, at no obligation, the literature I've indicated by the following key numbers:

New Equipment begins Page 8	*New Bulletins begins Page 130*	*Advertised Products begins Page 117*
No's	No's	No's

Your Name _____ **Title** _____

Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

Inquiries for items listed in this issue not serviced beyond December 1, 1952

FIRST CLASS
PERMIT No. 19
(Sec. 34.9, P.L.&R.)
ST. JOSEPH, MICH.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3¢—POSTAGE WILL BE PAID BY

INDUSTRY AND POWER

420 MAIN STREET

ST. JOSEPH, MICH.

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

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Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

Inquiries for items listed in this issue not serviced beyond December 1, 1952

Readers' guide to advertised products

This department is both a product index for advertising and a keyed listing for advertised literature. Refer to advertisement on page indicated and contact advertiser directly—or list paragraph key numbers on reader service card (page 115) to get data you want

AIR & DUST FILTERS & COLLECTORS

Dust Collecting System **500**
Information available on Schneible multi-wash dust collecting system. Claude B. Schneible Co. p 27.

Dust Collectors
Adv. p 32 contains data on Aerotec design 3 RAS dust collector. The Thermix Corp.

Dust Collector **501**
Illustrated "Dust Recovery" bulletin describes Buell dust collection systems. Buell Engineering Co. p 135.

ANTI-CORROSIVE & PROTECTIVE COATINGS

Rust Preventive **502**
Adv. p 43 contains coupon for complete information on Rust-Oleum sealing compound. Rust-Oleum Corp.

BOILERS & BOILER ACCESSORIES

Boilers
Adv. p 138 contains data on Kewanee-heavy-duty steel boilers. Kewanee-Ross Corp.

Steam Generating Units **503**
Bulletin contains data on Vogt two-drum steam generators. Henry Vogt Machine Co. p 65.

Boilers **504**
Complete data available on Wickes boilers. The Wickes Boiler Co. p 149.

Vertical Unit Boilers
See adv. p 19 for information on C-E vertical unit boilers. Combustion Engineering-Superheater, Inc.

Water Level System **505**
Adv. pp 20, 21 feature illuminator for flat glass gages. Bulletins cover complete water level system. Yarnall-Waring Co.

BUILDING HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION

Unit Heaters **506**
Bull DS-327A describes Trane line of unit heaters. The Trane Co. p 58.

BUILDING MATERIALS & MAINTENANCE

Metal Gratings
See adv. p 30 for metal grating for all types of floors. Klemp Metal Grating Corp.

Steel Grating **507**
Bull 2365 contains data on electroforged steel grating. Blaw-Knox Div., Blaw- Knox Co. p 120.

Iron Cement **508**
Coupon on page 146 offers free repair handbook describing Smooth-On repairs. Smooth-On Mfg. Co.

Thread Sealer **509**
Free sample of Key graphite paste for oil, gasoline, high-pressure steam piping. Key Company. p 144.

COAL, ASH & BULK HANDLING

Conveyor Belting **510**
Book "Production-eering for Industry" contains data on Quaker industrial rubber products. Quaker Rubber Corp., Div. of H. K. Porter Co., Inc. p 49.

Electric Vibrators **511**
Illustrated folder available on Syntron electric vibrators. Syntron Co. p 142.

Hopper Accessories **512**
Illustrated folders describe Syntron hopper level switches, electric vibrators and flow control valves. Syntron Co. p 140.

Concrete Stave Silos **513**
Full details on Marietta industrial storage systems and precast insulated concrete wall panels. The Marietta Concrete Corp. p 118.

CONTROLS, REGULATORS & INSTRUMENTS

Regulators
Adv. p 62 contains information on Spence pressure and temperature regulators. Spence Engineering Co.

Testing Instruments **517**
Bulletins available: wattmeter (GEC-591); Type CF recorders (GEC-215); Insulation Resistance meter (GEC-753). General Electric Co. p 44.

Temperature Control **518**
Bull 329 contains data on Powers No. 11 temperature indicating regulators. Powers Regulator Co. p 126.

Flow Indicators **519**
Details available on Henszey flow indicators. Henszey Co. p 142.

Temperature Regulators
Adv. p 113 contains data on Hoffman pressure reducing valves and temperature regulators. Hoffman Specialty Mfg. Corp.

Tank Gage **520**
Details available on Liquidometer tank gage. The Liquidometer Corp. p 146.

Thermometers **521**
Literature available on comprehensive line of Weston industrial thermometers. Weston Electrical Instrument Corp. p 123.

COMPRESSORS

Rotary Compressors **514**
Bull C-6 gives complete data on Fuller rotary compressors. Fuller Co. p 48

Motor-Driven Compressors **515**
Bull 118 contains data on Clark balanced-opposed, motor-driven air compressors. Clark Bros. Co., Inc. p 4.

Industrial Air Compressors **516**
Literature GS-52 describes Schramm's small industrial air compressors. Schramm, Inc. p 128.

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PRODUCT INDEX

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Marietta Concrete Wall Panels save 30% of new building costs

A revolutionary new development in precast insulated concrete wall panels is currently saving a large industrial firm as much as 30% on the construction of its new, multi-million dollar plant expansion.

These panels are designed for quick erection of curtain walls. A nine man crew is erecting 3,500 sq. ft. of finished wall in a day. The panels are made of high strength concrete and are cast solid, or cast with concrete facing and rigid insulation core. Marietta engineers report that tests show these panels have compression strengths over 4,000 psi. and an insulating U-value of 0.14, surpassing the usual 12-inch masonry wall in both these properties. Panels are cast in modular sizes to meet every building requirement. Full details and engineering service are available by writing to The Marietta Concrete Corporation.

Marietta Concrete Industrial Storage Systems cut material handling costs

Marietta concrete industrial storage systems are being used by a wide variety of leading industries for safe, permanent, low-cost storage and materials handling facilities. These concrete stave silos are available in any size, any arrangement to meet present and future storage requirements. They're designed for labor-saving, large capacity, efficient storage and will protect stored bulk raw materials from fire, moisture, air and acids at low cost. A complete Marietta storage system, including necessary materials handling equipment, can be designed and quickly erected to solve your storage needs. Write for full details.

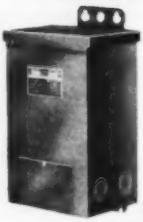
THE MARIETTA CONCRETE CORPORATION
MARIETTA, OHIO

BRANCH OFFICES: 509 FIFTH AVE. NEW YORK 17, N. Y.
PULASKI HWY. AT RACE RD. BALTIMORE 21, MD.

A NAME SYNONYMOUS WITH EXPERIENCE

MAGNATRAN

THIS CATOLOG MAY HELP YOU...



INDOOR-OUTDOOR TYPE
3 KVA to 15KVA inclusive. Modern design for quick, neat installations. Light weight. Air cooled.

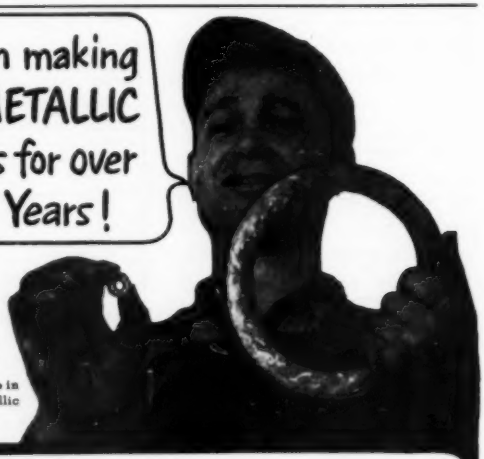
INDOOR TYPE
25 KVA to 200 KVA inclusive. Extra large junction box speeds hook-up.

WRITE FOR YOUR COPY TODAY

MAGNATRAN INCORPORATED
TRANSFORMERS AND ELECTRICAL EQUIPMENT
WALTER GARLICK, JR., PRESIDENT
246 SCHUYLER AVE., KEARNEY, NEW JERSEY

MAGNATRAN Trade Mark Pending

I've been making DURAMETALLIC Packings for over 20 Years!



DAN SMITH
23 years' experience in producing Durametallic Packings.

It pays to specify packing that has been produced by *packing specialists.* A score of men, like Dan, have been with the Durametallic Corporation for periods of 10 - 20 and 25 years. Convincing evidence why Durametallic Flexible Metallic Packings are performing the most dependable sealing jobs in industry.

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

Readers' guide to advertised products

(Continued from page 117)

DIESELS

Diesels
Adv. p 9 contains data on Cooper-Bessemer diesels. The Cooper-Bessemer Corp.

ELECTRICAL DISTRIBUTION

Switchgear **522**
Cat Section 6004 contains complete story on I-T-E low-voltage switchgear. The I-T-E Circuit Breaker Co. p 16, 17.

ELECTRICAL HEATING UNITS

"Packaged" Electric Heat **523**
Booklet "100 Ways to Apply Electric Heat" contains complete details on application of Chromalox heaters. Edwin L. Wiegand Co. p 47.

FANS & BLOWERS

Fans **524**
Cat 400 describes Chelsea explosion-proof fans for hazardous locations. Chelsea Fan & Blower Co., Inc. p 147.

Fans and Blowers **525**
Adv. p 2 will bring more information on Hartzell fans and blowers. Hartzell Propeller Fan Co.

FILTERS, STRAINERS & PURIFIERS

Flo-Klean Strainers **526**
Coupon on p 64 contains data on Cuno Flo-Klean strainers. Cuno Engineering Corp.

Twin Strainers **527**
Bulletin contains service-giving features of Elliott twin strainers. Elliott Co., Accessories Dept. p 137.

FUELS & FIRING EQUIPMENT

Coal
See adv. pp 12, 13 for information on bituminous coal. Bituminous Coal Institute.

Burner Units **528**
Bulletin describes Enco oil and gas burner units in many sizes. The Engineer Co. p 52.

Coal
Adv. p 120 contains data on this product. General Coal Co.

Spreader Stokers
Adv. pp 24, 25 contain information on Riley traveling grate spreader stokers. Riley Stoker Corp.

HEAT EXCHANGER EQUIPMENT

Instantaneous Water Heaters **529**
Engineering data available on instantaneous water heaters. Pick Mfg. Co. p 148.

Cooling Towers
Adv. p 109 describes Fluor induced draft cooling towers. The Fluor Corp.

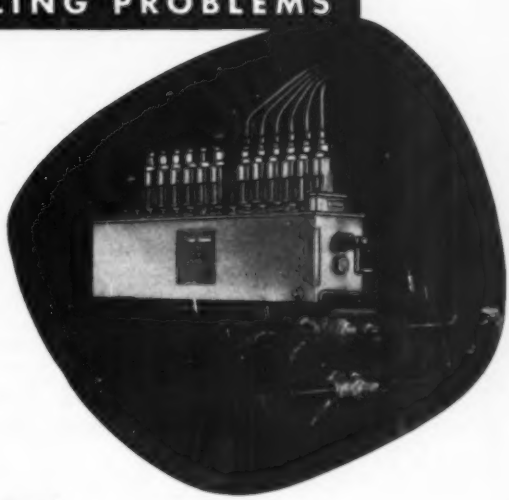
LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Lubrication Systems
Specialists in lubrication, filtration, oil storage, metering for industry. Bowser, Inc. p 23.

(Continued on page 121)

MANZEL SOLVES

OILING PROBLEMS



Manzel
lubricates Worthington Diesel

What's Your Problem?

Insure many years of economical, trouble-free service from all types of machinery with *Manzel* Force Feed Lubrication. Adaptable to numerous difficult oiling problems, "Manzel's" can be engineered to *your* requirements. Experienced representatives throughout the country.

Just Write

Manzel

271 BABCOCK ST., BUFFALO 10, N. Y.

RODA — High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

KENDRICK — High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA — High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

GLENBROOK — The Premium Kentucky High Splint unmatched for domestic use. Produced in Harlan County, Kentucky, on the L. & N. Railroad.

COKE — Roda and Stonega from Wise County, Va.

CRITERION COAL — High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

HAMPTON COAL — High volatile domestic, steam and by-product coal from Boone and Logan Counties, W. Va., on the Chesapeake & Ohio Ry.

CROZER — Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railway.

LYNCO — High fusion coking coal for by-product, industrial stoker and pulverizer use from Wyoming Co., W. Va., on the Virginian Ry.

ANTHRACITE

Hazel Brook—*Premium Lehigh*
Raven Run—*Premium Mahanoy*
Cross Creek—*First Grade Lehigh*

Our engineering service, available upon application, and long and varied experience is your assurance of the Right Coal — Properly Applied.

General Coal Company

123 SOUTH BROAD STREET PHILADELPHIA 9, PA.

CABLE ADDRESS, GENCO

Branches:

BLUEFIELD, W. VA. BUFFALO CHARLOTTE, N. C. CINCINNATI
NEW YORK NORFOLK PITTSBURGH

9800 American industrial leaders depend on Kroil when a frozen bearing, bushing or bolt threatens production or starts to cost expensive man hours.

During eleven years they have learned that it pays to use Kroil first and save parts. In these days of critical materials, shops cannot afford to use hammer-and-chisel methods when stuck-together parts cause trouble.

What Users Say!

"Five men using levers and sledges worked for an hour with a frozen shaft . . . one man used Kroil and lifted the shaft out with no leverage" . . . "Before trying Kroil we broke off every nut (on our heat treat quench trolleys) . . . since then we have not lost one and have decreased repairing time from 30 minutes to about six minutes per trolley."

Try Kroil at our risk. Send for a gallon—use it under the worst conditions you have. Return it for full credit if not satisfied. Kroil, $3.50 a gallon; Kroiler, $1.50 each . . . together, $4.75, f.o.b. Nashville.

KANO LABORATORIES
1085 Thompson Lane, Nashville 11, Tenn.

BLAW-KNOX STEEL GRATING
in the Front Rank of Industry
ON ALL 5 COUNTS

OPEN SPACE • STRENGTH
LONG LIFE • CLEANNESS
SAFETY

Blaw-Knox Steel Grating is electroforged into rigid, one-piece panels, using twisted cross bars for firm footing. Bring your open steel flooring problems to Blaw-Knox for expert help. Bulletin 2365 sent on request.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2072 Farmers Bank Bldg.
Pittsburgh 22, Pa.

BLAW-KNOX *Electroforged* STEEL GRATING

Readers' guide to advertised products

(Continued from page 119)

Lubricant
Adv. p 55 describes Standard HD oil. Standard Oil Co. (Indiana).

Turbine Lubricant **530**
Complete information available on Shell Turbo oil. Shell Oil Co. p 41.

Hydraulic Oils **531**
Coupon offers booklet "Hydraulic Fundamentals and Industrial Hydraulic Oils". Sun Oil Co. p 105.

Colloidal Graphite **532**
Bull 426-17H, "Use of Colloidal Graphite for Metalworking Operations." Acheson Colloids Co. p 57.

Force Feed Lubrication
Adv. p 119 describes Manzel force feed lubrication. Manzel, Inc.

Penetrating Oil **533**
See adv. p 120 for trial offer of Kano Kroil for loosening frozen parts. Kano Laboratories.

Oil Filters
Adv. p 144 contains data on Winslow oil filters. Winslow Engineering Co.

MATERIALS OF CONSTRUCTION

Nickel Alloy **534**
Technical Bull T-7 "Engineering Properties of Inconel." The International Nickel Co., Inc. p 61.

MECHANICAL POWER TRANSMISSION

Roller Bearings **535**
Hyatt Cat 150 describes Hyatt Hy-Load roller bearings. Hyatt Bearings Div., General Motors Corp. p 54.

Grommet V-Belts
Adv. pp 35, 36, 37, 38 discuss Goodrich grommet belts. The B. F. Goodrich Co., Industrial Products Div.

Couplings **536**
Cat 57-A describes Waldron improved gear type couplings. John Waldron Corp. p 139.

Flexible Couplings **537**
Catalog and quick-finding selector charts on Lovejoy flexible couplings. Lovejoy Flexible Coupling Co. p 131.

Steel Collars **538**
Literature describes solid steel collars. Hallowell Power Transmission Div., Standard Pressed Steel Co. p 147.

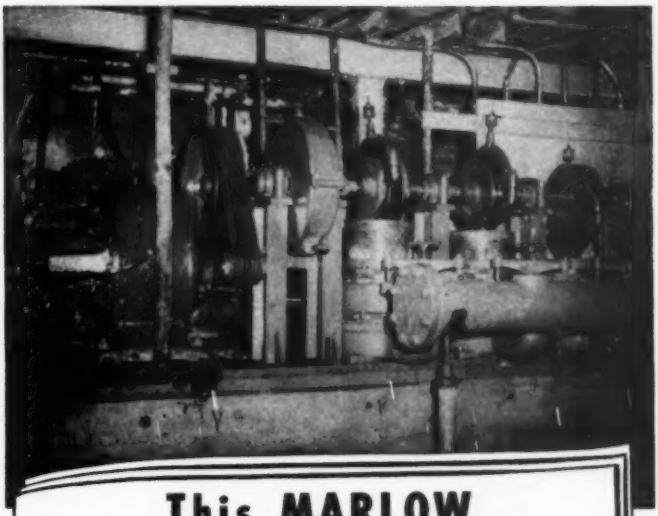
PACKAGED STEAM GENERATORS

Superior Steam Generators **539**
Cat 402 contains complete details. Also see this company's advertisement, page 130 July issue, for which usual readers' guide paragraph was unintentionally omitted from this section. Superior Combustion Industries, Inc. p 114.

Steam Generators **540**
Coupon p 26 offers catalog on Clayton forced recirculation steam generators. Clayton Mfg. Co.

Packaged Automatic Boiler **541**
Literature describes Continental pack-

(Continued on page 123)

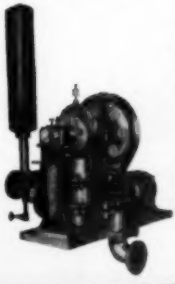


This MARLOW Plunger Sludge Pump Makes Paper "Flow" Smoothly

The Marlow Triplex above is moving semi-chemical neutral sulphite pulp from a stock chest to the beaters. The installation is at Watervliet Paper Co., Watervliet, Michigan.

Two other Marlow Plunger Sludge Pumps handle the long fibre pulp easily and steadily to keep the machine chests at required levels. One of these handles bleached sulphite from the bleach washer to a storage chest. The second pumps deinked and bleached waste paper from a bleach washer to a storage chest.

Marlow Plunger Sludge Pumps have a reputation for doing a beautiful job on bulky, thick, usually troublesome pumpage. They are consistently solving some of industry's most perplexing problems.



In your own industry, if you are concerned with heavy sluggish pumping of any kind, find out about the efficiency and durability of Marlow Plunger Sludge Pumps. And for your other pumping needs ask also about the famous Marlow Self-Priming Centrifugal Pumps — Portable and stationary models — and Marlow Portable Diaphragm Pumps.

Write today for name of dealer nearest you.

MARLOW PUMPS 515 GREENWOOD AVENUE RIDGEWOOD, NEW JERSEY

Manufacturers of the World's Finest Industrial Pumps

5 Reasons

STRONG* 70 Series Traps give better service!

Look to these five reasons for long, trouble-free service in STRONG 70 Series Traps:

1. *Valve and seat guaranteed leakproof for one year—made of* STRONG's *patented, wear-resistant Anum-Metl;*
2. *Easy servicing—permitted by the renewable seat design, cover with all working parts easily removed without breaking pipe connections;*
3. *One piece bucket—stainless steel, no welds;*
4. *Turbulence avoided, choking minimized, 25% greater capacity—with* STRONG's *exclusive Hi-Cap orifice;*
5. *No dribbling, quick, full opening—high ratio leverage.*

STRONG *in-line* 70 Series Traps are available in sizes from ½" to 1", semi-steel construction. STRONG's "two-in-one" blast trap with integral thermal air vent is also available in the 70 Series (see cut below).

Catalog No. 68-J describes these traps in detail along with other STRONG traps. Write today.

*Trademark Reg. U. S. Pat. Off.

STRONG, CARLISLE & HAMMOND COMPANY

1392 WEST 3rd Street
Cleveland 13, Ohio

† Anum-Metl Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

Reducing Valve

Blast Trap

"SY" Strainer

STRONG

THERE'S A PLACE IN YOUR PIPING FOR

WECO... WING UNIONS

- Ball and cone seating of male and female sub provides unequalled sealing ability.
- Heavy acme threads on female sub and wing nut make up fast, resist damage and distortion.
- Sub walls are extra thick for protection against distortion, vibration, shock and surge pressures.
- Available in sizes 1" through 10"; test pressures from 1000 psi through 15,000 psi.

Ask your WECO or CHIKSAN Representative or write for WECO catalog of the most complete line of wing unions in the world.

WECO

WELL EQUIPMENT MFG. CORP.

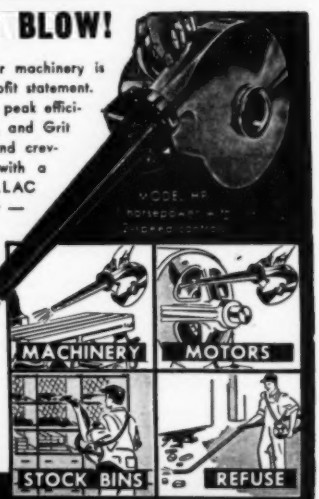
HOUSTON 1, TEXAS

CHIKSAN COMPANY

KNOCKOUT BLOW!

DOWN time for your machinery is OUT time on your profit statement. To keep operation at peak efficiency, keep Dirt, Dust, and Grit out of every crack and crevice. Knock 'em out with a CLEMENTS - CADILLAC blower-suction cleaner — regularly.

Eligible under C.M.P. regulations.



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Readers' guide to advertised products

(Continued from page 121)

aged steam generators. Boiler Engineering & Supply Co. p 112.

Packaged Steam Boilers **542**
Illustrated and descriptive Cleaver-Brooks Co. p 59.

Packaged Boilers **543**
Bull EC-100B contains data on Dutton Econotherm packaged boilers. Dutton Boiler Div., Hapman Dutton Co. p 28.

Packaged Boilers **544**
Catalog gives facts on Powermaster packaged boiler with Voriflow combustion. Orr & Sembower, Inc. p 106.

Self-Contained Generators **545**
Bull 201 gives installation and operating advantages of York-Shipley Steam-Pak generators. York-Shipley, Inc. p 125.

PACKING AND GASKETS

Packings **546**
Full details available on complete line of "John Crane" packings. Crane Packing Co. p 130.

Packings
Adv. p 60 contains data on R/M packings and gaskets. Raybestos-Manhattan, Inc. Packing Div.

Packings
Adv. p 118 gives data on Durametallic flexible metallic packings. Durametallic Corp.

PIPE AND FITTINGS

Expansion Joints **547**
Bulletin contains specifications on Flexon expansion joints. Flexonics Corp., Expansion Joint Div. p 46.

Flexible Metal Connectors **548**
Booklet SS-50 describes American flexible metal connectors and their uses. The American Brass Co., American Metal Hose Branch. p 40.

Wing Unions **549**
Catalog contains data on Weco wing unions. Well Equipment Mfg. Co. p 122.

Pipe Fabrication
Adv. p 131 gives information on pipe fabrication for industrial requirements. Albert Pipe Supply Co.

Flexible Metallic Tubing **550**
Folder "Flexineering" contains data on Penflex tubing. Pennsylvania Flexible Metallic Tubing Co. p 56.

Rubber Hose **551**
Special product information available on handling acid through rubber hose, Republic Rubber Div., Lee Rubber & Tire Corp. p 133.

Steam Hose
Information on HD glass cord steam hose and other industrial rubber products. Goodyear Tire & Rubber Co. p 3.

PUMPS

High-Pressure Pumps **552**
Bull P-295 describes American-Marsh triplex high-pressure pumps. American-Marsh Pumps. p 126.

(Continued on page 125)

WESTON TAG Thermometers

in all forms—ranges—stem lengths—connections

Whether your requirement calls for certified laboratory thermometers . . . or rugged all-metal industrial types . . . or thermometers for remote reading . . . you'll find *exactly* what you require in the Weston-TAG line—*the most comprehensive line of quality thermometers ever offered by ONE manufacturer.* Literature on request. WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey.

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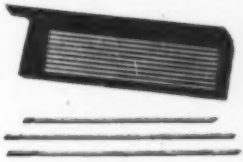

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—resistor bulb sensing element permits mounting indicator any distance away from point of measurement. *Multiple* remote readings also possible by use of selector switch and several bulbs.

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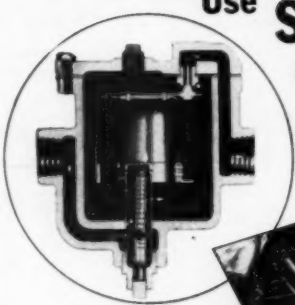

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Readers' guide to advertised products

(Continued from page 123)

Vertical Turbine Pumps
Adv. p 39 contains data on Worthington vertical turbine pumps. Worthington Corp.

Pumps **553**
Bull 105-M contains details on Aurora Type-OD centrifugal pump. Aurora Pump Co. p 124.

Plunger Sludge Pumps
Adv. p 121 contains information on Marlow plunger sludge pumps. Marlow Pumps.

Peerless Pumps **554**
Descriptive engineering bulletins on Type A and Type TU Peerless pumps. Peerless Pump Div., Food Mach. & Chem. Corp. p 33.

Metering & Proportioning Pumps **555**
Catalog and pump selection manual on Hills-McCanna "U" type metering and proportioning pumps. Hills-McCanna Co. p 136.

Pumps
Adv. p 111 contains information on Weinman pumps. The Weinman Pump Mfg. Co.

REFRACTORY CONCRETES

Refractory Cement **556**
Coupon offers catalog and prices on Super 3000 refractory cement. Refractory & Insulation Corp. p 129.

SOOT BLOWERS & TUBE CLEANERS

Soot Blower System
Adv. p 45 contains data on Diamond automatic "Air Puff" soot blower system. Diamond Power Specialty Corp.

Tube Cleaners **557**
Bull R-105 contains full details on Roto-jet tube cleaners. Elliott Co., Roto Div. p 143.

Tube Cleaners & Expanders **558**
Tube expander catalog and 48-page catalog describes complete Wilson tube cleaner line. Thomas C. Wilson, Inc. p 148.

STEAM SPECIALTIES

Impulse Steam Traps
Install a Yarway impulse steam trap on free trial anywhere in your plant. See p 66. Yarnall-Waring Co.

Traps **559**
Full details available on Clark steam traps with duo-stop leverage. The Clark Mfg. Co. p 29.

Traps **560**
Cat 68-J describes complete line of Strong traps. Strong, Carlisle & Hammond Co. p 122.

Steam Traps **561**
Cat 351 contains data on Sarco inverted bucket steam traps. Sarco Co., Inc. p 124.

Illinois Steam Traps **562**
Bull 35 contains data on Illinois steam traps. Illinois Engineering Co. p 144.

Steam Traps **563**
Coupon offers book "Solving Steam Trap Problems". The V. D. Anderson Co. p 150.

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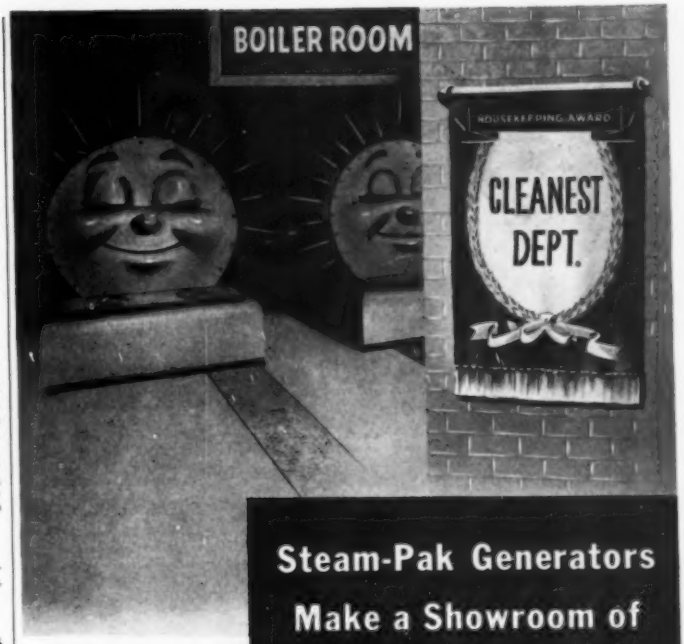

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THERMAL INSULATION

Heat Insulation

Adv. p 63 contains data on Kaylo heat insulation. Owens Illinois Glass Co., Kaylo Div.

Insulating Cement **564**

Coupon on p 124 contains complete data on Black Rockwell insulating materials. Baldwin-Hill Co.

TOOLS

Blower-Suction Cleaner

Adv. p 122 describes Clements-Cadillac portable blower-suction cleaner. Clements Mfg. Co.

Snap-on Tools **565**

Cat 52-1 contains data on complete line of Snap-on industrial wrenches and hand tools. Snap-on Tools Corp. p 141.

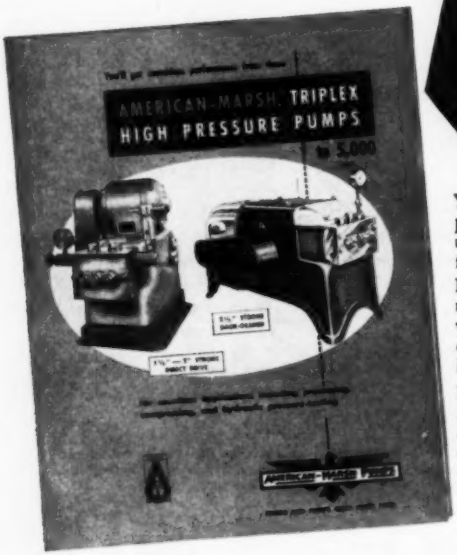
Tube Rolling Control **566**

Descriptive literature available on Airetool tube rolling control. Airetool Mfg. Co. p 127.

TRANSFORMERS

Transformers **567**

Catalog contains full data on MagnaTran



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CENTRIFUGAL, TURBINE, STEAM AND POWER PUMPS FOR TESTING, PROCESSING, BOILER FEED, FIRE PROTECTION, ETC.

dry type transformers. Magnatran Inc. p 118.

TURBINES

Steam Turbines

Adv. p 42 contains data on Terry steam turbines. The Terry Steam Turbine Co.

Turbines

Adv. p 53 contains information on Westinghouse general-purpose turbines. Westinghouse Electric Corp.

VALVES

Gate Valves **568**

Cat No. 10 describes Chapman List 900 forged steel gate valves. The Chapman Valve Mfg. Co. p 80.

Blow-Off Valves **569**

Bulletin describes boiler blow-off valves. Everlasting Valve Co. p 134.

Diaphragm Valves

Adv. p 7 contains information on Crane diaphragm valves. Crane Co.

Silent Check Valves **570**

Bull WH-851 on "Water Hammer, Cause, Effect and Control in Piping Systems". The Williams Gauge Co. p 131.

Multiport Valves **571**

Pub. 4150 describes Cochrane multiport relief valves. Cochrane Corp. p 140.

Valves **572**

Catalog describes automatic and manually controlled Rockwell valves. W. S. Rockwell Co. p 142.

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WATER TREATMENT

Water Treatment **573**

Bulletin "Experimental Studies of Boiler Scale at 2,500 psi." National Aluminate Corp. p 11.

Boiler Water Comparator **574**

Free data book "Modern pH and Chlorine Control". W. A. Taylor and Co. p 6.

Water Conditioning Service **575**

Technical Paper No. 115, "Carryover Prevention with Anti-Foam Agents". W. H. & L. D. Betz. p 15.

Water Treatment **576**

Information available on the use of organics for boiler water treatment. Power Chemicals Div., E. F. Drew & Co., Inc. p 51.

Softener System **577**

Details available on automatic Inversand zeolite water softener system. Hungerford & Terry, Inc. p 144.

Industrial Water Treatment **578**

Coupon on p 31 offers Bull 5000 on industrial water treatment. Another bulletin on No-Ox-Id rust preventives. Dearborn Chemical Co.

Water Conditioning **579**

Bull 611 contains complete facts on Elgin water conditioning for every need. Elgin Softener Corp. p 34.

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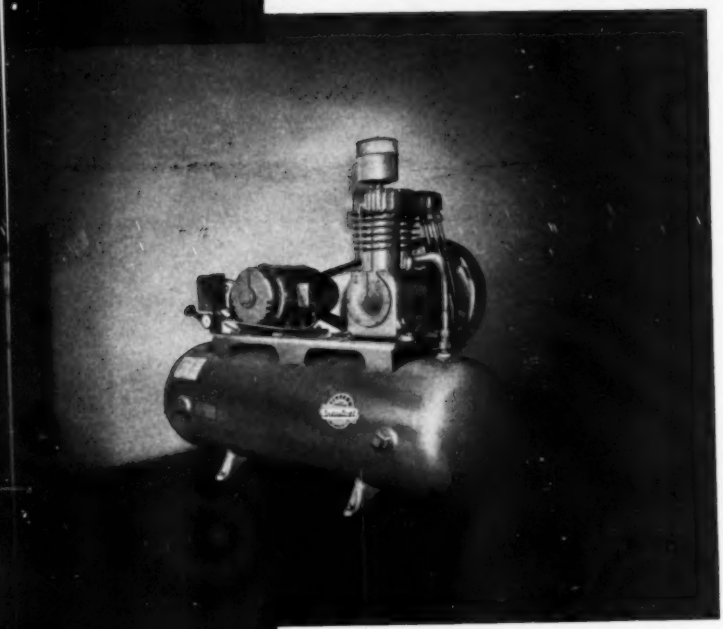

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This book is a comprehensive study of modern forging techniques, giving a very thorough study of impact, press and upset forging; extrusion, heat treatment of forgings, cleaning and finishing, inspection, safety, metal quality, the designing of forgings; tools and dies. There are more than two hundred carefully chosen diagrams, pictures and tables. The book is not only of permanent worth because it fills a genuine technological need, but also due to the present metal scarcity, it includes tables of substitute metals that may be safely used for unavailable originals.

Compressed Air

"Compressed Air in Mining and Industry" by Sydney H. North, late editor "Compressed Air Engineering". Distributed by Pitman Publishing Corporation, 2 West 45th Street, New York 19, N.Y. 161 pages, with illustrations, drawings, tables and graphs. Price $4.00.

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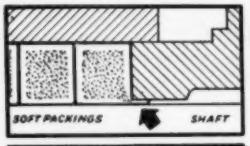
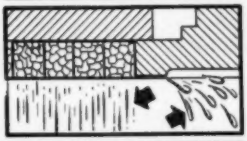
Combination Sets

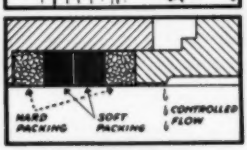
In the majority of cases, no one type of packing is 100% efficient. Therefore, "John Crane" recommends COMBINATION SETS to assure proper sealing. Here's why:



Straight soft packing used throughout permits end rings to squeeze into gland and throat clearances, thus sealing off the required amount of leakage needed to serve as lubricating film between shaft and packing.



Straight hard packing used throughout often is not sufficiently sensitive to gland pressure to control leakage within the desired limits. Also, the use of this single type of packing may result in scoring the shaft.



The right combination, however, of two types of "John Crane" packing offers better sealing, increased shaft life and less down-time in a variety of services. That's because soft inner rings are employed to provide a positive seal—yet allow Controlled Flow Lubrication, while harder end rings serve as a dam to stop inner ring extrusion.

...IN THE **POWER PLANT**

HERE'S THE RIGHT PACKING COMBINATION FOR CENTRIFUGAL CONDENSATE AND DRAIN PUMPS

End rings of "John Crane" twisted metallic packing Style 101-M and intermediate rings of "John Crane" Super Seal #1 is the combination best suited for steel shafted pumps handling hot water at medium pressures. Order a test set today and prove to yourself its advantages over your present packing.

Send Today for Full Details

CRANE PACKING COMPANY

1831 CUYLER AVENUE DEPT. 8 CHICAGO 13, ILLINOIS

Meetings and exhibitions

For additional information, please write sponsors of meetings

AUGUST

American Institute of Electrical Engineers, Pacific general meeting, to be held at the Westward Hotel, Phoenix, Ariz., Aug. 19-22. Details from H. H. Henline, secy, AIEE, 33 W. 39th St., New York 18, N. Y.

SEPTEMBER

Centennial of Engineering. Convocation period, comprising general meetings to be held in Chicago, has been scheduled for Sept. 3-13. For information write: 57th St. & South Shore Drive, Chicago 37, Ill.

American Society of Mechanical Engineers will hold its fall meeting concurrently with the Centennial of Engineering in Chicago, Sept. 9-11. Meeting headquarters will be at the Sheraton Hotel. For information write O. B. Schier, meetings manager, ASME, 29 W. 39th St., New York 18, N. Y.

Instrument Society of America holds the National Instrument Conference and Exhibit in Cleveland, Sept. 8-12. For exhibit information contact Richard Rimbach, exhibit manager, ISA, 921 Ridge Ave., Pittsburgh 12, Pa.

American Society of Mechanical Engineers, Petroleum Div. will meet Sept. 22-24 at the Hotel President, Kansas City, Mo. Details from O. B. Schier, meetings manager, ASME, 29 W. 39th St., New York 18, N. Y.

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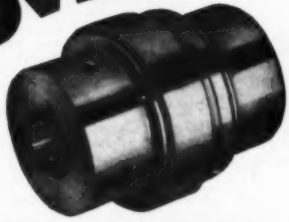

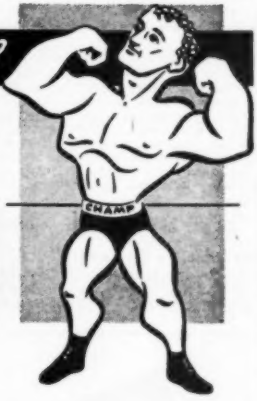

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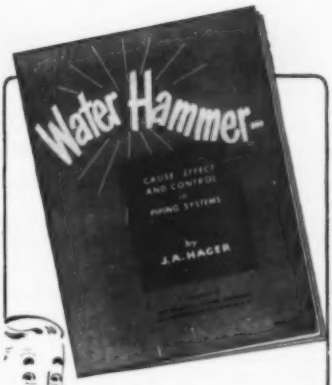

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This important new Bulletin WH-851 explains in detail the causes and damaging effects of costly Water Hammer—and how it can easily be controlled with Williams-Hager Silent Check Valves. Learn how Water Hammer can be quickly and inexpensively controlled *in your piping system*—send for your copy of this new bulletin today.

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New bulletins and catalogs

Literature on engineering products and developments

Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Insert key numbers on return post card found on page 115

ANTI-CORROSIVE & PROTECTIVE COATINGS

Corrosion-Resistant Coating **200**

Described in 4-page folder 5-5251 is a cold-setting phenolic resin coating formulated to protect equipment against highly corrosive conditions. Physical properties, resistance to various chemicals and industrial applications are listed. Ric-wil Plastic Coating & Mfg. Corp.

Water Repellent **201**

Uses and application of silicone type transparent water repellent for exterior masonry are discussed in a 4-page product manual. Especially useful is a section devoted to the control and elimination of efflorescence. The Surface Protection Co.

Protective Coating **202**

"The One Best Answer for Protecting and Restoring Masonry Structures," 20-page booklet B-58, describes a heavy masonry coating said to be capable of resealing itself when outer surface is broken. Actual applications on well-known buildings are discussed. The Arco Co.

Rubber Linings **203**

Application of rubber lining to prevent corrosion of tanks, pipes and valves is discussed and illustrated in 4-page folder. In addition, a 2-page reprint tells how rubber lining can stop circulating pipe corrosion. La Favorite Rubber Manufacturing Co.

Acid-Proof Materials **204**

Technical data concerning anti-corrosive materials and construction is offered in three bulletins. Bulletin 160 describes thermoplastic material in sheet form for lining tanks and other vessels, and acid-proof cement for structural work such as floors and basins. Bulletin 190 discusses a lacquer developed to provide an anti-corrosive coating on interior and exterior surfaces. The third bulletin, No. 130, describes and lists specifications for acid and alkali-resistant pipe and fittings. Aqua-Therm, Inc.

BOILERS & BOILER ACCESSORIES

Visual Smoke Indicators **206**

Operation and installation of a smoke periscope possessing a 90 deg vision angle are described in 4-page folder 5101. Also presented are furnace indicators which permit visual observation of furnace conditions. Ess Specialty Corp.

BUILDING HEATING, VENTILATING & AIR CONDITIONING & REFRIGERATION

Central Control Systems **207**

Technique for use in designing economical automatic electric control installations for heating and air conditioning systems is outlined in 8-page bulletin F-5265. Wiring diagrams, specifications and advantages of central control panel systems are presented. Barber-Colman Co.

Refrigerant Purger **208**

"How to Cut Your Refrigeration Costs and Get More Capacity from Your Refrigeration System," 4-page folder 221-15, discusses the problem of air and non-condensable gases. A purger for venting air from the system is described. How it operates and physical data are presented. Armstrong Machine Works.

Heaters **209**

Direct-fired heaters, either gas or oil, are described in 12-page bulletin 523-B. In addition to space heating, information is presented concerning use of the units for other applications. Included are functional heating, process drying, temporary heating, medium temperature drying, tempering make-up air and integration with air conditioning systems. Dravo Corp.

COAL, ASH & BULK HANDLING

Bulk Handling Equipment **210**

Concise descriptions, including specifications and illustrations, for complete line of equipment for bulk handling is presented in 52-page miniature catalog 525. Various types of vibrators, hopper level switches, flow control valves, feeders, screens, and vibratory elevators are presented. Also described are products such as mechanical shaft seals, selenium rectifiers, electric heat elements, pile hammers, rock drills and many types of tools. Syntron Co.

Vibrating Conveyers **211**

Mechanical vibrating conveyers are the subject of 12-page brochure 849. Advantages, the drive, material movement and applications are discussed. Several types of feeders also are presented. The Jeffrey Manufacturing Co.

Rolling Ring Crusher **212**

Construction features of a rolling ring crusher for reducing coal and other materials to uniform size are described in 8-page bulletin. Engineering data and typical installations in mines and power plants are presented. American Pulverizer Co.

BUILDING MATERIALS & MAINTENANCE

Vibration Control **213**

Isolation pad material for control of transmission vibration is the subject of 4-page folder ER-702. Advantages, construction, applications and engineering data are presented. The Korfund Co., Inc.

(Continued on page 134)

Worm Gear Motors **205**

Design features of right angle worm gear motors are discussed in 8-page bulletin 1650. Full color cutaway views illustrate construction, and advantages gained by each design improvement are discussed. The production technique used in manufacture of the units also is described. Upright, variable speed and flange mounting types are described for single or three phase service. Speeds from 20 to 155 rpm with gear ratios up to 58 to 1 are available. Ratings are ¼ to 3 hp. Speeds are standard as recommended by NEMA and AGMA. Splash proof and totally-enclosed models also are available. U. S. Electrical Motors Inc.

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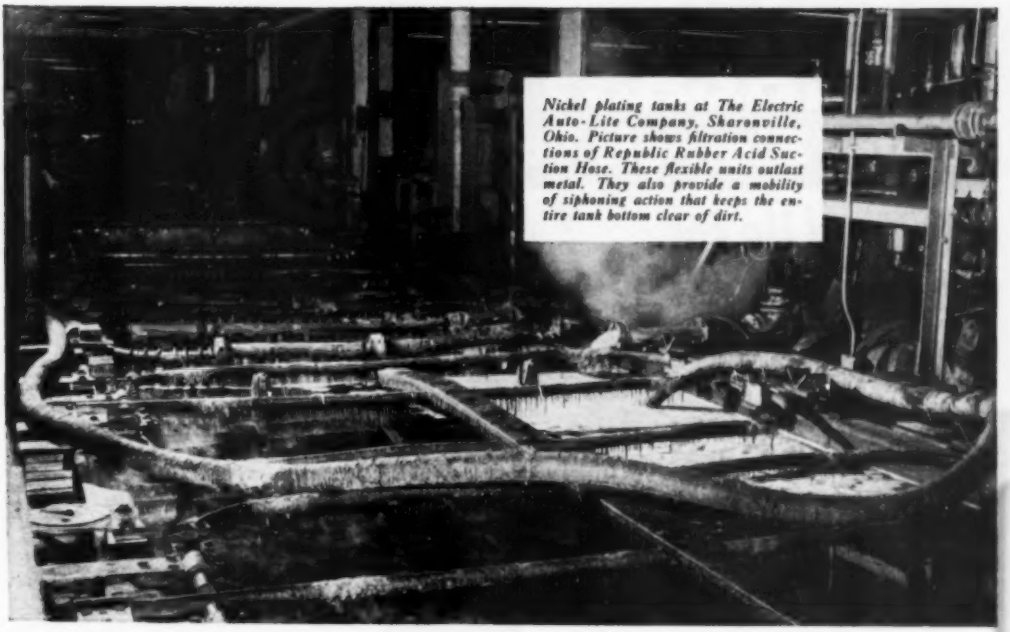

Nickel plating tanks at The Electric Auto-Lite Company, Sharonville, Ohio. Picture shows filtration connections of Republic Rubber Acid Suction Hose. These flexible units outlast metal. They also provide a mobility of siphoning action that keeps the entire tank bottom clear of dirt.

Case history of—HANDLING ACID THROUGH RUBBER HOSE

Getting a flexible carrier that could handle nickel plating solution was the problem facing The Electric Auto-Lite Company, Sharonville, Ohio.

The solution, in addition to being highly acid, is saturated with ionized particles of nickel. Ordinary rubber hose had a tendency to pick up these particles. What's more, the acid eventually penetrated to inner hose reinforcements, which were destroyed.

Carriers of metal pipe were no better. In the first place, they weren't flexible. The acid slowly dissolved the pipe wall, leaving a dangerously thin shell that could give out any time without warning.

What was the answer? Well, Auto-Lite called in their local Republic Rubber Distributor, an expert in Industrial Rubber applications, who recommended use of Republic Acid Suction Hose.

This flexible carrier is specially built to withstand action of either acids or alkalies. It's made with rugged abrasion-resistant cover, a sealed-in, metal-reinforced carcass and a tube that can handle caustic liquids at temperatures up to 150° F.

The Electric Auto-Lite Company is highly pleased with the performance of this Republic Rubber Hose. They like the quick, sure way Republic Distributors diagnose, then solve difficult problems in the application of Industrial Rubber Products.

We suggest that you may also enjoy doing business with a company that for 52 years has specialized both in building better rubber products and giving you better service at the local level.

Write today for special product information and the name of your nearby Republic Distributor.

INDUSTRIAL RUBBER PRODUCTS BY
REPUBLIC RUBBER DIVISION
Lee Rubber & Tire Corporation
YOUNGSTOWN, OHIO

EVERLASTING
Boiler Blow-off Valves...

Teamed Up For "EVERLASTING" Service

The unique service qualities of EVERLASTING Blow-off Valves have long been demonstrated in boiler-rooms throughout the country. Now their superior design features have been teamed up in these new EVERLASTING Duplex Blow-off Units.

HERE'S WHAT YOU GET WITH THESE NEW DUPLEX UNITS

Sealing Valve (shown on left of unit)

- Lever- or wheel-operated types—as you desire
- Unrestricted flow — straight-through
- Rotating sliding disc—self-grinding, self-lapping
- Drop-tight seal—improving with use
- Non-wedge action — no sticking, no jamming

Blowing Valve (shown on right of unit)

- Straight-way or angle types to select from
- Strength to withstand repeated shock of blow-off force
- Exceptional resistance to erosion, abrasion and rust
- No pockets to permit lodgment of solids
- Positive action, self-cleaning

Not only do these EVERLASTING Duplex Blow-off Units provide an absolutely drop-tight seal — they are so constructed that long and repeated operation will not affect this tightness. Other Duplex Units for varied requirements are shown in our Bulletin.

Either valve of any EVERLASTING Duplex Unit can be supplied separately. But for boiler blow-off applications, any one of the complete EVERLASTING Duplex Units assures absolute safety — at low maintenance cost.

Ask your distributor — or write directly to us — for complete information.

EVERLASTING VALVE CO., 49 FISK STREET, JERSEY CITY 5, N. J.

EV 3188A

Everlasting Valves

Trade-Mark "EVERLASTING" REG. U.S. PAT. OFF.

for everlasting protection

New bulletins and catalogs

(Continued from page 132)

CONTROLS, REGULATORS & INSTRUMENTS

pH Control **214**

Bulletin 430-1, 16 pages, reviews the pH theory and gives practical applications in industrial measurement and control. Contained in the booklet is an explanation of the units employed in the pH control cycle, as well as details of the instruments, typical process applications and accessory equipment. The Foxboro Co.

Industrial Instruments **215**

Bulletin 300, 16 pages, contains descriptions of many types of scientific and industrial instruments. Included are pH meters, spectrophotometers, micro-microammeter, ultrohmeter, flow calorimeter and radioactivity instruments. Beckman Instruments, Inc.

Thermocouples **216**

Instrument sensing units and associated accessories are described in 42-page catalog TC-9. Listed in the table of contents are many types of thermocouples, radiation detectors, resistance bulbs and accessories for indicating, controlling and recording instruments. Data pertaining to making, checking, selecting and ordering thermocouples, wire sizes and resistances make this manual a useful asset in applying indicating, controlling and recording instruments. Barber-Colman Co., Wheelco Instruments Div.

Temperature Regulators **217**

Specifications for various types of temperature regulators are given in mechanical drawings contained in 18-page bulletin 50-1000-08. Information on the why of control accuracy as well as on installation, care and maintenance is presented. Also lists accessories. Farris Stacon Corp.

CRANES, HOISTS & CAR PULLERS

Overhead Handling Equipment **218**

"Tramrail Engineering and Application Data," 12-page booklet 2008-H, explains what overhead materials handling systems consist of and the advantages of this type of system. All important features are described, including method of track support, carrier designs, motor head construction, track switches, cranes, automatic interlocks and types of electrification. The Cleveland Crane & Engineering Co., Cleveland Tramrail Div.

DIESEL & ENGINE ACCESSORIES

Intercoolers **219**

Supercharger air intercoolers for cooling compressed air between the supercharger blower and the air manifold leading to cylinders of diesel, natural gas or dual fuel engines are described in 4-page folder 1652. Both low and high pressure systems are discussed. Young Radiator Co.

ELECTRICAL DISTRIBUTION

Push Button Controls **220**

Oil-tight push button controls, including standard, extended and mushroom buttons, 2 and 3 position selector switches and pilots, together with suitable legend plates are described in 12-page catalog. Features such as oil-tight construction and interchangeability also are dealt with. The Arrow-Hart & Hegeman Electric Co.

Electrical Connections 221

Cadweld process, described in 76-page electrical connection catalog, is a method of welding copper to copper or steel without an outside source of heat. Equipment to form many types of electrical connections is described. Types of connections include cable, ground rod, horizontal and vertical surface, rail bonds, bus bar, tubular bus and stud. Erico Products, Inc.

Selenium Rectifiers 222

Designed for power conversion in d-c industrial applications, selenium rectifiers described in 8-page bulletin are available in many types and sizes to meet specific needs. Details of design, advantages, installation and applications are discussed. Richardson-Allen Corp.

Selenium Rectifiers 223

Advantages, operation and applications of selenium rectifier power conversion units are discussed in 4-page folder 01163. Specifications for units from ¾ to 500 kw are listed. Syntron Co.

Motor Controls 224

"Electrically Speaking," 84-page catalog M-78A, has been prepared as a quick reference guide for the various motor controls and allied equipment available. Described in the booklet are diversified products such as magnetic brakes, clutches and separators, controls, switches, regulators, starters, resistors, rheostats, electronic equipment and heater elements. Cutler-Hammer, Inc.

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Motor Control Centers 225

How to lay out a motor control center is explained in 8-page folder 400. Construction features, advantages and specifications for the units are presented. Continental Electric Equipment Co.

Resistors 226

How to select the proper resistor is told in the data section of 64-page catalog 15. In addition, a quick selector chart is employed. Useful data for the engineer includes list of basic equations, nomographs of Ohm's law and parallel resistance, and information on ordering procedure. Descriptions and specifications for numerous types of resistors, both stock and made-to-order, are given. Terminals, mountings and enclosures are also presented. Ward Leonard Electric Co.

Cable Connectors 227

Recommendation charts contained in 36-page catalog AL53 detail advantages of connectors for specific applications in tapping and splicing aluminum conductor in overhead distribution. Tools and accessory equipment are presented. A technical section outlines problems encountered in connecting aluminum and the solutions, as well as presenting tables of physical properties and current ratings of aluminum cable. Burndy Engineering Co., Inc.

FILTERS, STRAINERS & PURIFIERS

Liquid Strainer 228

Installation arrangements for a liquid strainer are shown diagrammatically in 2-page data sheet W-6. Application, parts lists, working pressures and dimensions for the units are presented. Golden-Anderson Valve Specialty Co.

(Continued on page 136)

This 'dust' man can help you...

Solve Stack Dust Problems

He assures peak efficiency in Fly Ash Collection on boilers from 50 hp to 'the biggest yet'!

Most probably you know of the benefits you obtain from the recovery or collection of industrial escape-dust: new, higher efficiencies, a boost in employee morale, more favorable plant-community relations.

But—unless your dust collecting system is designed to the individual requirements of your plant, much of these potential benefits stand to go up the stack.

As a result, a Buell Engineer is a good man to know. Buell's staff of industrial 'dust' men draw on more than 200 man-years of experience in the design and construction of high-efficiency, trouble-free Dust Collection Systems. They can discuss the success of hundreds of Buell Installations, and how one can be designed for you.

For full information about the ***three basic systems*** of efficient Dust Collection and Dust Recovery write today. Ask for the new illustrated Buell 'Dust Recovery' bulletin. It can be a highly profitable move. Buell Engineering Company, Dept, 90-H, 70 Pine Street, New York 5, N. Y.

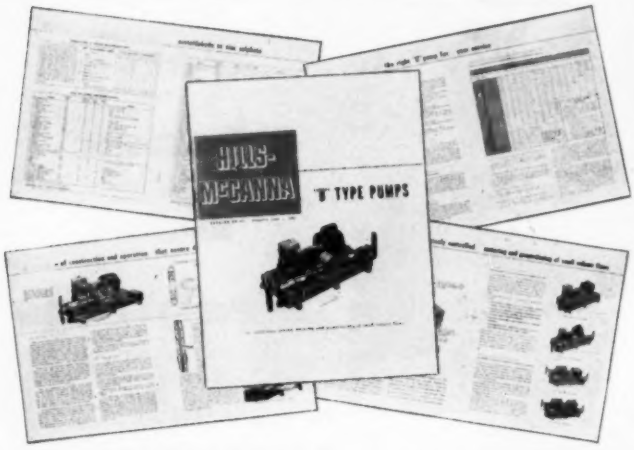
ELECTRIC CYCLONIC

HIGH EFFICIENCY CYCLONES • ELECTRIC PRECIPITATORS
TYPE 'LR' COLLECTORS • LOW DRAFT LOSS COLLECTORS
SPECIAL PURPOSE COLLECTORS • DUST HOPPER VALVES

buell

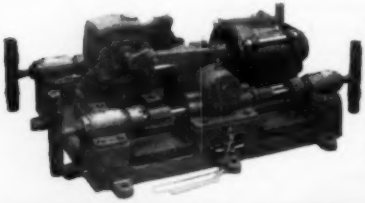
ENGINEERED EFFICIENCY IN DUST COLLECTION

Here's a handy guide to the selection of metering and proportioning pumps



In this new catalog and pump selection manual for Hills-McCanna "U" Type Metering and Proportioning Pumps is all the information, including prices, for the selection of exactly the right pump for handling over 300 substances. Clearly and concisely, this helpful booklet gives all the necessary information and specific recommendations to cover the vast majority of needs that can be filled with a Hills-McCanna "U" Type Pump.

If your operations involve the metering or proportioning of small volume flows, you will find this catalog a useful addition to your files. We will be pleased to send you a copy on request. HILLS-McCANNA COMPANY, 2355 W. Nelson St., Chicago 18, Illinois.



Hills-McCanna "U"-Type Pumps are reciprocating, variable stroke, mechanical drive units with maximum capacities ranging from 0.10 to 24 gph. per feed. One, two, three and four feed assemblies are available. Operating pressures up to 5,000 psi. A four feed unit is shown at the left.

HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of: Saunders Patent Diaphragm Valves Force Feed Lubricators • Magnesium Alloy Sand Castings

New bulletins and catalogs

(Continued from page 135)

FANS & BLOWERS

Ventilating Fans **229**

Descriptions, including specifications and dimensions of many types of fans and blowers, are presented in 30-page catalog 400. Included are industrial ventilating, vertical discharge line pressure, duct-booster, air blaster and penthouse unit fans, and multiple exhauster blower units. Engineering data on how to select and install the proper fan is included. Chelsea Fan & Blower Co., Inc.

ELECTRICAL HEATING UNITS

Electric Radiant Panels **230**

How electric radiant panels can be used for paint baking, curing, drying, degreasing and other operations is explained in 6-page folder CS-605. In addition to discussing advantages of this type of infrared generator, the bulletin lists dimensions, ratings and intensity controls. Edwin L. Wiegand Co.

MATERIALS OF CONSTRUCTION

Corrosion-Proof Cements **231**

Technical data included in 12-page brochure 5-2 should be useful to engineers concerned with corrosion-proof brick and cement construction. Four basic types of cement are discussed. Charts indicate temperature range for each, and tables list resistance to 176 common chemicals. Three principal types of construction are shown in association with materials estimating tables. Atlas Mineral Products Co.

Technical Handbook **232**

Compiled as a ready reference source, this 168-page leatherette-bound handbook contains considerable useful information concerning brass mill products. The manual has been revised to include the latest developments in high strength, corrosion resisting copper-base alloys. Many useful tables of engineering data are presented. Bridgeport Brass Co.

FUELS & FIRING EQUIPMENT

Underfeed Stokers **233**

Underfeed stokers which automatically feed coal directly from the coal bin are described in an 8-page booklet. Details of construction and advantages are discussed. Blue prints of a typical boiler room layout show how the stoker and automatic controls can be applied to new or existing boilers. Actual installations also are dealt with. Canton Stoker Corp.

Rotary Burners **234**

Rotary burners for use with any type of oil or commercially available gas ar the subject of an 8-page brochure. Actual

installations under various types of boilers are pictured. Operation, advantages and specifications are presented for nine sizes of units providing a capacity range of 5 to 167 gph of oil. Superior Combustion Industries, Inc.

Oil Burning System **235**

Principle of operation of a wide range burner control employing a controlled fuel return from the atomizer tip by means of a constant differential pump system is described in 4-page folder 109-B. Advantages are discussed and photos depict actual installations. Peabody Engineering Corp.

HEAT EXCHANGER EQUIPMENT

Heat Exchangers **236**

Heaters, coolers, condensers and heat exchangers for all types of liquids, vapors and gases are pictured and briefly described in 8-page booklet. Sections are arranged to show some of the types of apparatus made by the company which are of particular interest to the oil and gas industry, power plants, general industrial and chemical plants. The Griscom-Russell Co.

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Cooling Towers **237**

Single and double squirrel cage blower type and horizontal induced draft fan type cooling towers for capacities from 1 to 100 tons of refrigeration are the subject of 8-page bulletin 47-A. Advantages, specifications, performance data and selection tables are presented. Binks Manufacturing Co.

HYDRAULIC EQUIPMENT

Hydraulic Cylinders **238**

How cylinder powered mechanical movements cut costs and speed production on all types of machines and equipment is discussed in 6-page folder, "Cylinder Power in Action." Sixteen cylinder powered movements are described and illustrated with 21 actual application photos. Hydraulic and pneumatic cylinders as well as manually and electrically operated control valves are described. Hanna Engineering Works.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Lubricants **239**

Product index for 1952, 6-page folder, is compiled as a quick reference to complete line of available processing and maintenance products, including lubricants, mechanical leathers, metal and textile oils and chemicals. Trade name and application for each product is listed. E. F. Houghton & Co.

MECHANICAL POWER TRANSMISSION

Transmission Belting **240**

Engineers concerned with the design and operation of transmission belting should find 16-page booklet NY-8697-T a useful source of information. In addition to several pages of fundamental data concerning the selection and application of belting, tables give belt speeds, horsepower correction factors and other pertinent information. Several types of transmission belting are described. New York Belting & Packing Co.

(Continued on page 138)

Protected against wear and corrosion

ELLIOTT TWIN STRAINERS

The valve screw is entirely covered by the long valve shaft, internally threaded to run on the screw. Liquid cannot touch the screw threads, cannot corrode them nor wash off their lubrication.

The valve disc of gate valve type has an inserted rubber ring which operates like a windshield wiper on the valve seat as the valve is being closed. The disc can easily be taken out for replacement of the rubber ring after long use.

The wearing plate supplied for particularly corrosive conditions, is simply a removable valve seat which can readily be replaced when required.

These are only some of the service-giving features of Twin Strainers. Get them all — write for the Twin Strainer Bulletin.

A-318

ELLIOTT COMPANY

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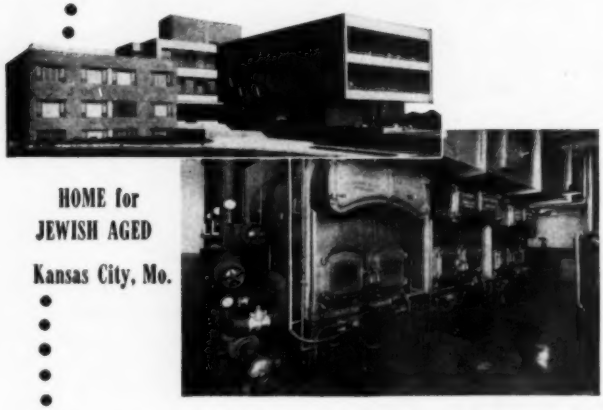

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Division of American Radiator & Standard Sanitary Corporation
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Serving home and industry

New bulletins and catalogs

(Continued from page 137)

V-Drives **241**

Equipment for V-drives in the fractional to 10 hp range is presented in 44-page catalog f-10. Specifications for bushed and fixed bore cast iron and pressed steel V-pulleys, V-belts, refrigeration fans and fan pulleys are listed. An engineering data section provides helpful information for the selection of the proper drive. Maurey Manufacturing Corp.

MOTORS & GENERATORS

D-C Motors **242**

Construction features for heavy duty, adjustable speed d-c motors are described in 4-page folder 8400. In ball bearing designs, the motors are available in open, drip-proof drip-proof protected and totally enclosed non-ventilated construction. Sleeve bearing designs are built in open type enclosures only. Electric Boat Co., Electro Dynamic Div.

Induction Motors **243**

Construction features of squirrel cage induction motors are described in 12-page bulletin 720. Insulation, mountings and typical applications are discussed. The Louis Allis Co.

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Induction Motors **244**

Over 100 case histories telling of applications of steel frame induction motors in varied industries are depicted in 36-page booklet B-4709. Each gives problems involved, the motor choice for the job and the results. Westinghouse Electric Corp.

Induction Motors **245**

Construction features, ratings and dimensions of Allis-Chalmers open drip-proof and splash-proof squirrel cage induction motors are described in 6-page folder 51B6210D. Ratings are ½ to 100 hp. Allis-Chalmers Manufacturing Co.

PACKAGED STEAM GENERATORS

Scotch Boilers **246**

Factory assembled, fully automatic Scotch boilers described in 4-page folder 9100 are for low pressure heating and process services. Advantages, specifications and dimensions are listed. Standard burners supplied with the units are for No. 3 or lighter fuel oils. Capacities are from 11 to 52 hp. Johnston Brothers, Inc.

PACKINGS & GASKETS

Packing **247**

Ready-to-use general purpose packing is the subject of 4-page folder 443. Recommended uses, specifications and installation data for several types, described as combinations of metallic and plastic packing, are presented. Durametallic Corp.

Rod Packing **248**

Construction and advantages of lattice-braid rod packing are outlined in 8-page bulletin AD-131. Drawings point out how

lattice-braid construction differs from other types of braided packing. General recommendations and specifications are listed in table form. Reports from users also are included. The Garlock Packing Co.

PIPE & FITTINGS

Threadless Pipe Connectors 249

Tightly sealed flexible pipe joints can be made without threading by using a threadless connector described in a 4-page folder. Details of construction, installation and suggested applications are given. Tables list specifications for straight couplings, 45 and 90 deg ells, male adapters and welded adapters for pipe sizes from ⅛ to 1½ in. IPS. Quick-Joint Manufacturing Co.

Expansion Joints 250

Many styles of packless expansion joints are described in 28-page brochure 35-51A. Useful engineering data section presents table of thermal expansion for pipe as well as selection and installation data. Specifications are listed for quick reference. American District Steam Co., Inc.

Pipe & Fittings 251

Resin-bonded Fiberglas pipe and fittings for anti-corrosion service are described in series of data sheets. Other equipment including tanks and vent hoods also is presented. A test report on chemical resistance of the material to many corrosive media is included. The Chemical Corp.

Corrugated Expansion Joints 252

Specifications, applications and installation data for corrugated expansion joints are contained in 8-page bulletin CMH-119R. Three types are described for pressure ranges up to 5500 psi and temperatures to 1600 F. Flexonics Corp.

Carbon Steel Tubing 253

Technical information of value to engineers associated with the fabrication of equipment operating at elevated temperatures and pressures is presented in 4-page folder 142. The bulletin contains condensed data on mechanical and physical properties, upsetting, swaging, flanging, expanding, bending, and welding of seamless and welded carbon steel tubing. The Babcock & Wilcox Co., Tubular Products Div.

PUMPS

Controllable Capacity Pumps 254

Details of construction, applications, operation and advantages for controllable capacity pumps are presented in 8-page bulletin 65A. Diagrammatic layout shows arrangement of automatic hydraulic stroke-control system for boiler feeding, oil burner supply and similar applications. The Aldrich Pump Co.

Centrifugal Pumps 255

Pedestal and close coupled centrifugal pumps made of corrosion resistant alloys are the subject of 12 data sheets, section C. Mounting dimensions, cross section

(Continued on page 140)

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better built to eliminate sources of operating trouble

The steadily growing preference for these sturdy WALDRON couplings in all major industries is a tribute to the quality and workmanship that goes into them. Power is transmitted through solid forged steel hubs and one piece sleeves, for added assurance of safety at high speeds. All adverse and crank action on shaft and bearing is eliminated and an ever-present lubricant carries the load with no chance of wear from metal-to-metal contact. Their design permits use of smaller physical capacity for same size shaft. Longer trouble-free service makes these couplings the most economical to buy and use.

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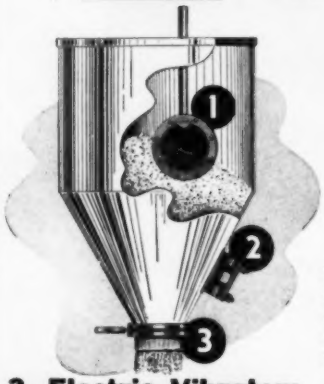

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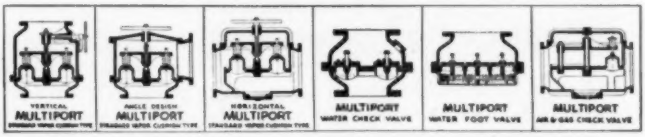

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"This valve in service about 28 years with no maintenance."
"Savings cannot be computed. Absence of trouble is worth the price."
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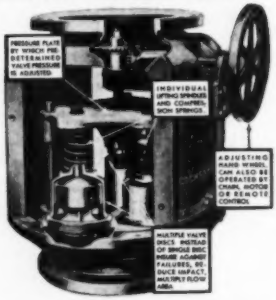
"No breakdown, no trouble, no expense."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New bulletins and catalogs

(Continued from page 139)

drawings and capacity curves are given. Sizes from 1¾ to 4x3 in. are listed. Ampco Metal, Inc.

Controlled Volume Pumps **256**

Details of construction, operation and application for air-powered controlled volume pumps and systems are contained in 16-page bulletin 351. Air consumption and capacity-pressure tables are included for pumps handling from 0.4 to 405 gph against discharge pressures to 21,000 psi. Milton Roy Co.

STEAM SPECIALTIES

Steam Traps **257**

Engineers concerned with steam traps should find 48-page catalog J a valuable source of data on recommended trapping practice. In addition to explanations of how to calculate condensate loads and select traps, a maintenance section covers installation, preventive maintenance, trouble shooting and repair. Numerous types of steam traps also are described. Armstrong Machine Works.

WATER TREATMENT

Glucosates **258**

"A New Way to Buy Glucosates," 4-page folder, announces the availability of glucosates in drums, ready for use. Eleven different tyes of glucosates are described. The particular use each has in correcting and controlling corrosion, scale and algae is discussed. D. W. Haering & Co., Inc.

Gravity Filters **259**

Information concerning gravity filters, contained in 24-page booklet 2539A, should be useful to engineers concerned with water problems. Specifications, operation, dimensions and typical installations of filters and accessories are included. Section presenting data for selection of equipment includes nomograph for selecting wash trough dimensions. The Permutit Co.

Dealkalization Process **260**

Increased capacity of anion exchange resins is claimed for a dealkalization process described in 3-page circular. How gas blanketing is prevented during regeneration is described. A complete unit for softening and dealkalizing water is offered. American Water Softener Co.

Cold Process Softener **261**

Advantages and facts concerning a cold process water softening method are contained in 16-page brochure W-212-B5. Cutaway view shows equipment construction, and flow diagram shows auxiliary equipment. Worthington Corp., Water Treatment Section.

Amine Treatment **262**

"Corrosion Protection of Steam and Condensate Return Systems," 4-page folder CP100, tells how amine treatment works to prevent corrosion. Advantages and disadvantages for this type of treatment are discussed. The Bird-Archer Co.

Mixed Bed Demineralizer **263**

System consisting of a single ion exchange unit containing a homogeneous mixture of cation and anion exchanger is described in 4-page folder. Advantages and applications are outlined. The Permutit Co.

VALVES

Diaphragm Control Valves **264**

Descriptions of diaphragm control valves are contained in catalog section 105. In addition to models described in previous literature, several recently announced styles to meet specific requirements are described. Black, Sivalls & Bryson, Inc.

Check Valves **265**

Hydraulic double cushioned check valves are the subject of 2-page data sheet WS-1. Drawings are used to show complete list of parts. Application, construction, sizes and pressures are described along with tables giving general dimensions. Golden-Anderson Valve Specialty Co.

Valves & Fittings **266**

Engineers concerned with handling corrosive solutions should find 54-page catalog 47 a valuable source of information. Stainless steel valves and fittings are presented. Of particular value is a section on alloys and their analyses and another section giving specific recommendations of valve materials for use with nearly 400 different corrosive media. Alloy Steel Products Co., Inc.

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Air Inlet Valves **267**

Reasons for using vacuum breaking valves in thin walled pipe lines are explained in 20-page booklet 1202. Construction details, operation, valve sizes, application, dimensions and information on installation are discussed. Actual installations are shown. Condensed engineering data and charts for selection of proper sizes and required number of valves are presented. Simplex Valve & Meter Co.

MISCELLANEOUS

Graphitization **268**

Research findings concerning the graphitization phenomena encountered in systems operating at elevated temperatures in the power and processing industries are reported in 12-page booklet. Preventive and corrective measures are listed. The effects of chemical composition, deoxidation practice, pre-welding microstructure, welding conditions, stress and strain also are discussed. Edward Valves, Inc.

Multi-Louver Dryer **269**

Basic principles of heat drying are explained in 24-page booklet 2409, as well as other useful engineering information. Included is a 2-page psychrometric chart. Multi-louver dryers for drying, cooling and processing such bulk materials as coal, food, chemicals and fertilizers are described. Fast treatment and close temperature control is provided. Link-Belt Co.

(Continued on page 143)

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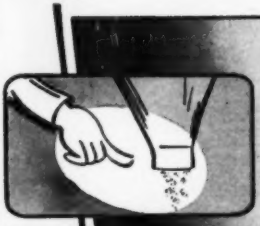
The Way to Assure Free-Flowing Hoppers, Bins and Chutes



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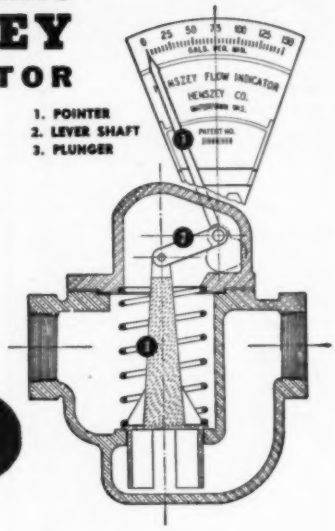

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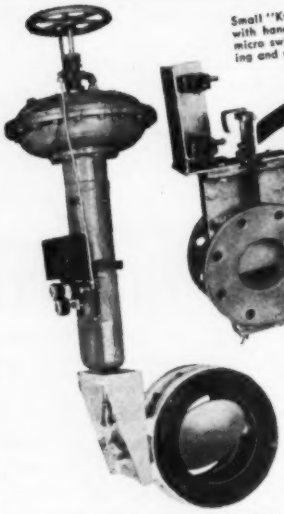

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Power Specialist

Articles describing the use of such building materials as insulation, asbestos cement and Transite are found in this publication. In addition to exterior and interior building applications, stories are presented describing the use of the products for construction and insulation of equipment such as dryers, ovens and piping. Johns-Manville Corp., 22 E. 40 St., New York 16, N. Y.

Weather Magic

Air conditioning systems in various industries and commercial buildings are the theme of the 8-page house organ. In addition to stories of actual installations, an engineering article is featured in each edition. In Vol. 16, No. 2, this article is entitled "Selecting Fans for Parallel Operation." The Trane Co., La Crosse, Wis.

Industrial News

Installations of V-belt drives are reviewed in 4-page monthly folder. Other industrial products manufactured by the company, such as rubber linings and industrial hose, are described in special editions. The stories illustrate cost-cutting and production-boosting experiences of actual users of these products. The Gates Rubber Co., Sales Division, Inc., 990 So. Broadway, Denver 17, Colo.

Betz Indicator

Modern water conditioning practices are the theme of this 8-page monthly publication. Featured in Vol. 21, No. 6, is an article describing latest filtration practices. Diagrams and photos of equipment are used for illustrations. A second subject dealt with in this issue is entitled, "Choose Your Water Consultant Carefully." W. H. & L. D. Betz, Gillingham & Worth Sts., Philadelphia 24, Pa.

S-A Conveyor

Materials handling engineers and users of conveying-elevating, screening and transmission equipment will be interested in this house organ. Installations of equipment in many different industries are described. All articles are well illustrated with photos and diagrams. Vol. 200, 20 pages, contains 15 feature articles describing installations of equipment for handling such materials as coal, chemicals, food products, clay, iron ore, slabwood and wood flour. Stephens-Adamson Manufacturing Co., Aurora, Illinois.

Taylor Technology

Industrial instrumentation is the subject of 28-page quarterly publication. A wide variety of industries and instrumentation problems are represented. In addition, engineering articles offer practical information and items on new instruments keep the engineer posted on the latest developments. Taylor Instrument Companies, Rochester 1, N. Y.

Link-Belt News

Devoted to the application of materials handling and power transmitting machinery, this 8-page tabloid is published to aid engineers in solving modern problems of industry. Vol. 19, No. 6, a typical issue, contains articles on conveyer systems used by a feed processing firm, an electrolytic zinc plant and a chemical plant. Descriptions of new equipment and picture-caption stories of industrial news also are included. Link-Belt News, 307 N. Michigan Ave., Chicago 1, Ill.

—End

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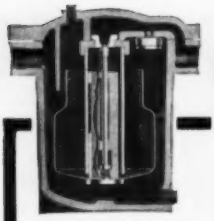

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Simple—moving parts are valve and bucket.

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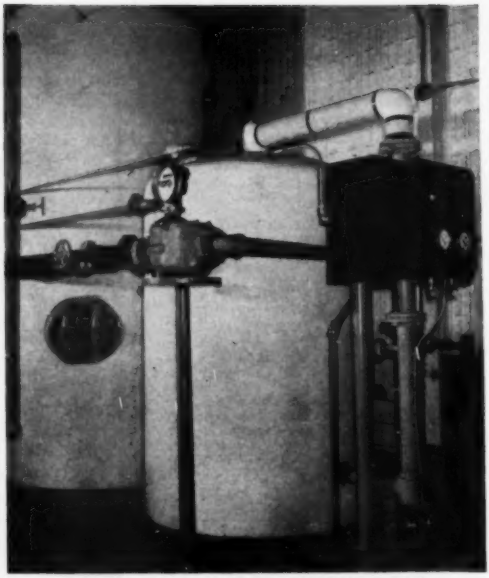

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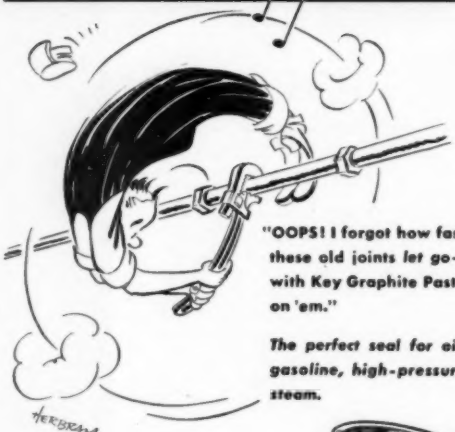

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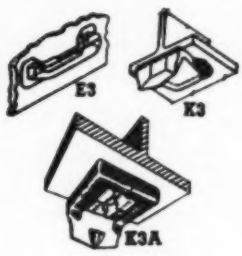

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For your personal reference file, following reprints, free of charge:

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"Valve Positioners," April, May, 1952
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"Meeting Gas Curtailment with Propane," April, 1952
"Quaker Designs Plant for Ease of Operation," March, 1952
"Tylertown Gas Compressor Station," March, 1952
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"Proper Water Tower Means Water Conservation," March, April, 1951
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"Practical Considerations in Applying Axial-Flow and Mixed-Flow Pumps," Sept., 1951
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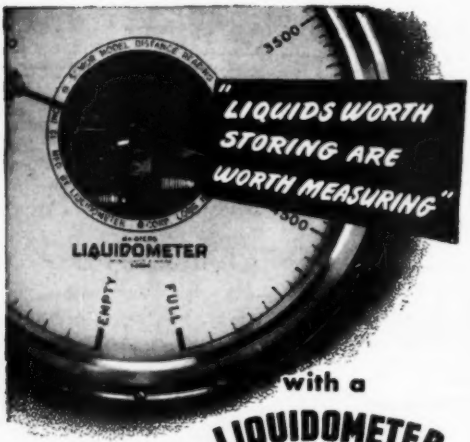

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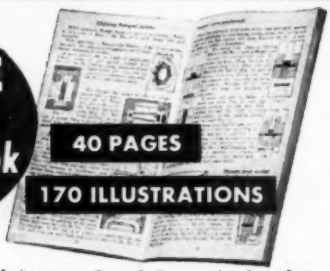

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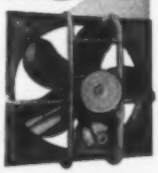
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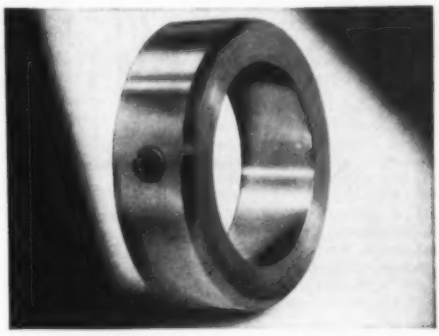

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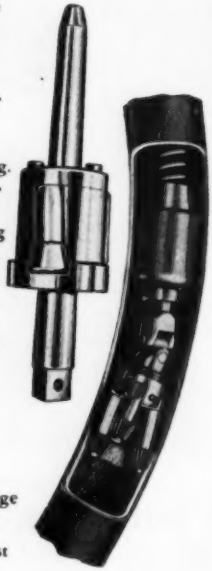

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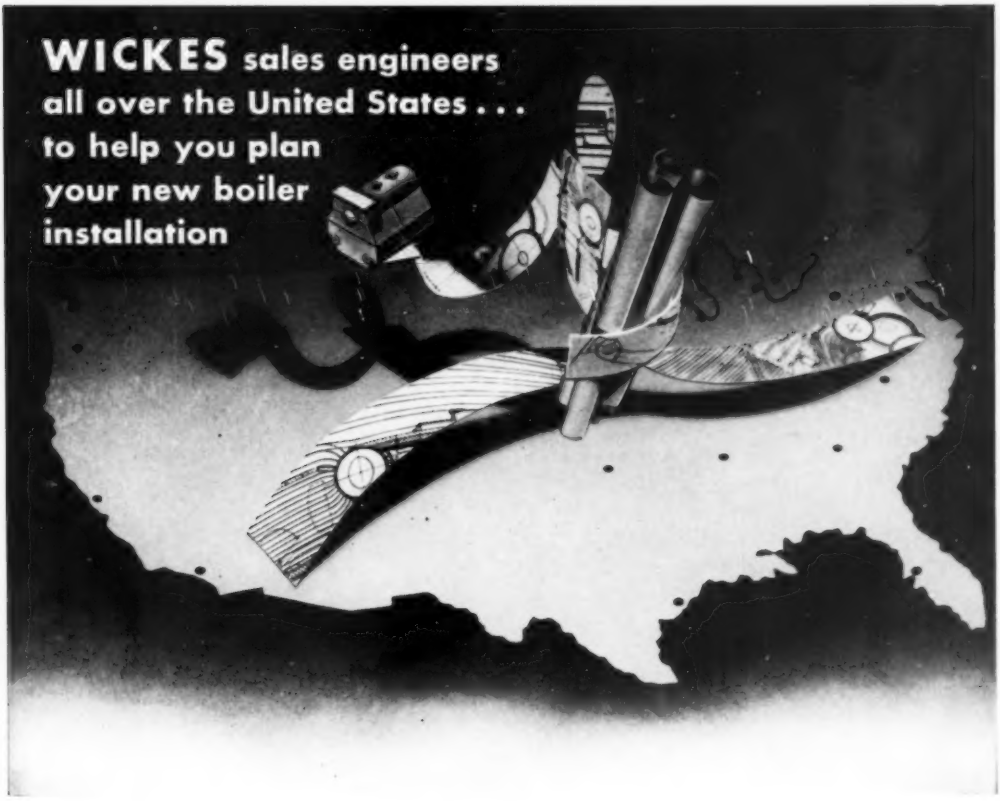

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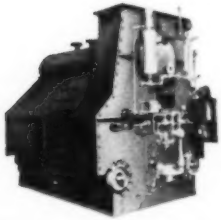

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